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Danish Hypogeous Macromycetes

By
Morten Lange

COPENHAGEN
EJNAR MUNKSGAARD
1956

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Danish

Hypogeous Macromycetes

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ANDELSBOGTRYKKERIET I ODENSE

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Introduction

Previous studies

The study of the hypogeous fungi has been much neglected in Scandinavia. ELIAS FRIES himself apparently paid little attention to this peculiar biological group of fungi, and the species described by him are often difficult to interpret, although he had good material sent from the early students of the hypogeas: VITTADINI in Italy, the TULASNES in France and BERKELEY in England. Brief floristic accounts of the Danish species were given by SAMSØE LUND (1874) and E. ROSTRUP (1884) while the only thorough studies of the Scandinavian forms were published by TH. M. FRIES (1909) and (for the *Gasteromycetes*) by TH. C. E. FRIES (1921). For the rest it is necessary to look for information in minor contributions by BUCHWALD, NANNFELDT, E. ROSTRUP and others, including several mostly scattered records of specimens found by gardeners and mycological amateurs. FERDINANDSEN and WINGE (1943) have short descriptions of all Danish species recorded up till then, a total of 18 species. Only recently has the group been taken up for extensive studies by ECKBLAD in Norway and by the present author.

It soon appeared that although the hypogeous fungi certainly are more rare here than in Middle and Southern Europe, there are many more species in our flora than previously known, and a number of these are even of common occurence.

Our knowledge of hypogeous fungi was founded by VITTADINI; his Monographia (1831) is the real starting point for the classification, but it was soon followed by more extensive works by the TULASNES, BERKELEY & BROOME, and CORDA. The German species were dealt with somewhat later by HESSE. These works are still our main source for the study of hypogeas. It may, however, be noticed that the TULASNES accepted almost all VITTADINI's species, but only identified the smaller part of them with material found by themselves; HESSE, again, recorded from his own province of Germany almost all species described by both VITTADINI, BERKELEY, and TULASNE, and added several new ones, and lately MALENÇON (*Tuber*, 1938), and SOEHNER (*Hymenogaster*, 1952a) have kept all

and added some. A closer comparison of the species described by the classical authors is very much needed. FISCHER (1897 and later papers) have contributed some towards this aim, working out the synonymy of several, especially tuberaceous, species, and ZELLER and DODGE have aimed at the same in their various publications on gasteromycetaceous hypogeas, although their results are obscured through their interpretation of European type material on American species, often leading to some confusion.

The great number of species recognised by nearly all these authors contrasts to the much more restricted number found by HAWKER (1954). Her account rests mainly on BERKELEY and BROOMES tradition, but almost all her descriptions are based on material collected by herself, thus avoiding the duplication, which makes most other floras so difficult to work with.

Geographical distribution

A large number of the *Ascomycetes* treated in the present paper has hitherto been reported from more southerly stations only. It is still premature to draw more detailed conclusions about the geographical range of the species, as our knowledge of the hypogeas in Norway and Sweden is somewhat insufficient. There are indications, however, that such conspicuous species as *Tuber aestivum* and *T. excavatum*, here in Denmark are near their northern limit. They are both very rare here. The same may very well hold true for the three species of *Pachyphloeus*, hitherto unknown from Norway and Sweden, and probably also for some of the small forms (*Tuber* spp., *Genea verrucosa*, *G. klotzschii*). On the other hand, it is true that many *Gasteromycetes* rare or unreported as yet in Denmark, occur further to the north. *Hysterangium* spp., *Rhizopogon* spp., *Gautieria* spp., and *Chamonixia caespitosa* are even recorded from montaneous regions of Sweden and Norway (cp. FRIES, 1921, LANGE & HAWKER, 1952), and there is reason to believe that at least *Chamonixia* is a true montaneous species. It is originally reported from the Alps. Some of the remaining *Gasteromycetes* may have a southern distribution, e. g. the rare *Melanogaster tuberiformis*.

Ecology

The ecology of the hypogeas has been very ably dealt with by HAWKER (1954, 1955), and my observations concur in the main with her results. The large majority of the species prefer well aerated, basic or slighlyt

acid soil; many of them seem even strongly attached to calcareous soils, and can be expected to occur very rarely in Denmark, where suitable habitats of this type are rare. The main habitat for the Danish species seems to be deciduous woods on mull, often of a rather light, sandy type. They are very often encountered along paths in such woods, may be because they are most easily found in places, where the firmness of the soil probably induces fruiting closer to the surface. A rather well defined group of fungi is often found together here, including such species as *Lachnea hemisphaerica*, *Galactinia succosa*, *Inocybe maculata*, *I. geophylla*, and *Lactarius blennius*. The hypogeas most frequently found in this company are *Tuber maculatum*, *T. rufum*, *Hymenogaster niveus*, *H. arenarius*, *H. vulgaris*, and *Genea verrucosa*. Most of the *Elaphomyces* species seem to prefer distinctly acid soil with hard morr, but hardly any other hypogea is found here. The *Rhizopogon* spp. seem in this country to be confined to sandy soils, sometimes growing even in old sanddunes.

The largest part of my material was collected in deciduous woods, mostly under beech. *Hymenogaster tener* seems almost exclusively attached to oak, and a few other species may prefer other deciduous trees than beech. The species of *Rhizopogon* have proved to form mycorrhiza with pine (cp. Young, 1937, Modess, 1941) and have only been met with under this host. Also some species of *Elaphomyces* seem attached to conifers, probably forming mycorrhiza, but no other Danish species have been found exclusively or even most commonly under conifers.

Fruit bodies of *Elaphomyces* are found throughout the year, while the remaining species are most frequent at the height of the fungus-season in the deciduous wood: late August to early September. Fully developed specimens are occasionally met as early as June and also as late as December–January when the epigeal fungus flora has disappeared after frost.

Material and descriptions

To arrive at a correct nomenclature it has been necessary to study authentic material from Vittadini, Tulasne, and Berkeley. There are numerous specimens from Vittadini to be found in various European collections (cp. Mattirolo, 1907), and the designation of the proper type will call for an extensive revision, outside the scope of this work, but specimens from Torino, Paris, Kew, and Uppsala (Herb. E. Fries) have been studied. Tulasne's specimens are in Paris, and I have had the opportunity to study some of these, while only a few specimens from

Berkeley & Broome have been acquired, as they have been dealt with by Hawker.

The main part of the Danish material treated here was identified before Hawker's flora appeared. It has been a major concern to avoid accidental discrepancies between the two treatises. Dr. Hawker has greatly facilitated this by placing material of a large part of her species at my disposal, and also by extensive correspondence. Studies of above mentioned authentic material have, however, caused some inevitable changes in nomenclature and species concept. Authentic specimens, and other important non-Danish material seen, are mentioned in the text.

The Danish finds are listed for each species, except the most common ones. It seems that all previous finds of importance have been preserved in our herbaria. This material has been revised and included in the proper lists with reference to the original place of publication if previously reported. The main part of the Danish collections have, however, been made by the author and his cooperators.

The following abbreviations are used in the lists:

Collections:

ABK (followed by number) = in Herb. Axel B. Klinge, duplicates in M.H.
M.H. = in Botanical Museum, University of Copenhagen.
ML (followed by number) = authors collections, deposited in M.H.
PAH (followed by number) = in Dept. of Plant Pathology, Royal Veter. and Agric. College, Copenhagen.

Geographical localities:

F. = Fyn (Funen).
J. = Jylland (Jutland).
S. = Sjælland (Zealand).

Almost all species have been described from fresh material. All microscopic characters refer, however, to dried material revived in Lactophenol, if not otherwise stated. This has some importance when evaluating the measures of peridium and septa, and for the color of the spores. Chemical reactions have been found distinctive in few cases only, as very few of the species show distinctive features when treated with Iodine or KOH. Some hyaline structures have been studied in KOH with phloxine added. The colors are given partly in general terms but in the majority of the cases there have been made references to Ridgway's Color Standard (1912) (indicated by capital letters), and to the corresponding shade in the color chart published by J. E. Lange (1926) (e. g. pallid dull brown, Clay Color (h3)).

Acknowledgments

The author is indebted to the curators of the Herbaria in Kew, Paris, Torino, and Uppsala for the loan of numerous specimens. Also to professor N. F. BUCHWALD, who kindly gave me access to the collections of the Departement of Plant Pathology. I have benefited much from cooperation with Dr. LILIAN HAWKER, Bristol and Mr. F.-E. ECKBLAD, Oslo. I want especially to thank my cooperators, Mr. A. KLINGE, Randers, and Mr. K. BÜLOW, Slagelse, for their enthusiastic assistance, which has helped to fill severe gaps in this treatise.

Survey of the main groups of hypogeous fungi

Chlamydospores, zygospores or sporangia born on loose weft of hyphae in poorely organized fruit body	*Phycomycetes – Endogonaceae* p. 12
Spores broad to globose, rarely smooth, in 1–8 spored asci. Fruit body with distinct peridium; gleba with open cavities or transversed by veins	*Ascomycetes* p. 17
Spores narrow to globose, born on basidia; mature spores with distinct pedicel or scar from sterigma at base; gleba chambered	*Basidiomycetes* p. 50
Fruit bodies small, black, hard, without spores...	*Fungi imperfecti – Cenococcum* p. 78

Phycomycetes

Endogonaceae

Endogonaceae is the only family among the *Phycomycetes* characterized by a distinct fruit body which, however, is of a rather loose texture, with a scanty peridium and a gleba made up of spores in a loose weft of hyphae. The species are found under the leaves or more or less deeply buried in the soil. Almost all collections recorded here are from rich clayey soil, but other species are said to grow among *Sphagnum*.

Our present knowledge of the group is mainly due to the careful study by Bucholz (1912) who demonstrated the zygomycetaceous nature of the species. An extensive study of American species was published by Thaxter (1922). The determination of the species was greatly facilitated through the key published by Zycha (1935), including all well described taxa. The Danish species have either zygospores or chlamydospores, (sometimes termed azygospores), and belong in the genus *Endogone*. The

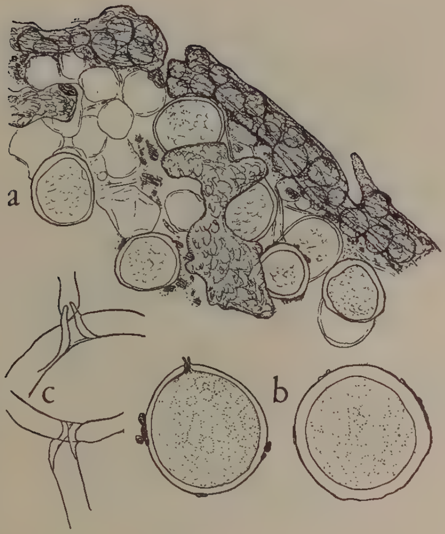

Fig. 1. *Endogone macrocarpa*: a Section of peridium and gleba with chlamydospores and vesiculae (×80); b Two chlamydospores (×160); c Insertion of spore stipe (×650).

genus *Modicella*, with true sporangia, has not been met with here as yet.

The present account of the species is mainly identical with the enumeration published by LANGE & LUND (1955).

Endogone LINK ex FRIES

Key

1. With zygospores, sometimes with strongly developed exospore . . . . *E. lactiflua* p. 15
1. With chlamydospores 2
2. Spores almost globose . . . . *E. macrocarpa* p. 13
2. Spores ovate-oblong, bright yellow . . . . *E. flavispora* p. 14

Endogone macrocarpa (TUL.) TUL. 1851, p. 182.

Syn.: *Glomus macrocarpus* TUL. 1844.

Fig. 1, p. 13.

Fruit body subglobose, lobed, often somewhat flattened, diam. up to 1.5 cm but frequently smaller; peridium thin to moderately thick, dirty whitish to clay color, somewhat reddish when bruised; gleba clay to brownish olivaceous, not very compact.

Peridium made up of branched hyphae and globose cells with debris; chlamydospores globose to short oval, formed as globose swellings on

Fig. 2. *Endogone flavispora*: a Section of peridium and gleba with chlamydospores and vesiculae (×80); b Two chlamydospores (×160).

ends of hyphae, yellowish olive to brownish, with slightly paler, granular content, often with some oil globules, 86–178×71–159 μ, walls 3–13 μ thick, homogeneous, refractive, incrusted on surface, spore stipe 6–9 μ thick, simple; spores irregularly arranged among hyaline, incrusted hyphae, 6–15 μ thick and often anastomosing; among the spores are distributed compact groups of abortive spores (vesiculae).

Under leaves or hypogeal in deciduous woods and in parks; probably not uncommon.

Danish finds: ML4034, Vallø Dyrehave, S., Sept. 16, 1951; – ML4051 a–b, Hald Hovedgård, J., Oct. 1, 1951; – ML4060, Boserup Skov, S., Oct. 20, 1951; – ML4259, Rosenvold, J., Sept. 9, 1952; – ML4600, Frederikslund Skov, S., Oct. 2, 1955.

Endogone flavispora M. Lange & Lund 1955, p. 92.

Fig. 2, p. 14.

Fruit body firm, almost globose, somewhat lobed, diam. 0.5 cm; peridium whitish, brown when touched and on drying; gleba darker, yellowish to dark brown, not much incrusted with soil.

Peridium of thick, brown hyphae mixed with vesiculae; vesiculae very few in central part of gleba, where azygospores are irregularly arranged among 6–12 μ broad, branched hyphae with thin walls; chlamydospores ovate-oblong, often slightly constricted on the middle, rarely subglobose,

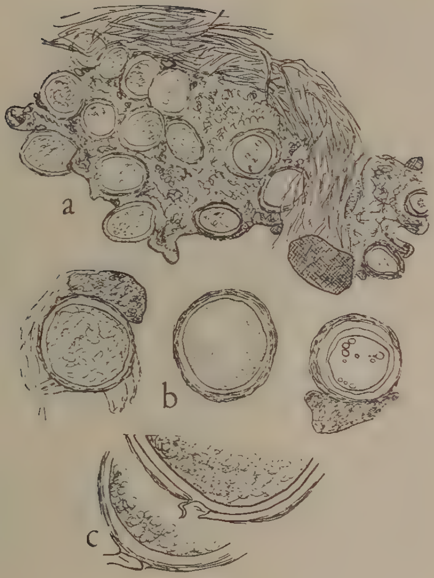

Fig. 3. *Endogone lactiflua*: a Section of peridium with zygospores ($\times$80); b Three zygospores ($\times$160); c Insertion of spore stipe ($\times$320).

149–202 $\times$ 95–152 μ (individual spores varying from 171 $\times$ 95 to 159 $\times$ 152 μ), wall deep yellowish brown, 6–13 μ thick, outer thin layer somewhat lamellate, hardly incrusted, content paler, bright yellowish, granular; stipe 10–13 μ thick, simple.

The species differs from *Endogone macrocarpa* Tul. through shape and color of spores. *Endogone tuberculosa* Lloyd from New Zealand has spores of similar shape and color but much smaller; the characters of the outer spore wall recall some types of *Endogone lactiflua*, but the spores are azygotic and differ in shape and color.

Danish find: ML4054, under *Corylus* on clay, Firegårde Skov, Ry, J., Oct. 16, 1951 (type).

Endogone lactiflua Berk & Br. 1846, p. 81.

Fig. 3, p. 15.

Fruit body firm, irregular, rounded, 0.4 cm broad; peridium white, fibrillose; gleba granulate, greyish brown, moist when sectioned, but no distinct milky juice seen, incrusted with debris.

Gleba made up of irregularly arranged spores or in some places spores in regular rows, densely mixed with incrusted substratum particles,

amorphous refractive exudate and hyaline, 4 μ broad hyphae; the hyphae continuous with the prominent peridium, made up of several layers of interwoven, hyaline hyphae; zygospores hyaline to dull yellowish grey, 95–120 × 76–111 μ, wall rather thick, with an often narrow, homogeneous inner layer, and a very variable outer layer made up of lamellae or subcellular tissue, not sharpely delimited from the surrounding hyphae; stipe short, more or less distinctly indicating the zygoteous nature of the spores.

Although the "Flammenkrone" structure is not as distinct as in BUCHOLZ' drawings (1912), I have little doubt to the identity of the species. The zygoteous nature of the spores and also the "Flammenkrone" is according to THAXTER (1922) often hard to see, and the material checks well with some of the specimens described under this name by both these authors.

Danish find: ML4185, Rude Skov, S., under Fagus, Aug. 11, 1952.

Another specimen, ML4055. Firegårde Skov, Ry, J., Oct. 1951, reminds in several respects of *Endogone lactiflua*. It differs, however, in much larger spores (95–212 × 82–181 μ) and also in other, minor characters. It may belong in a species hitherto undescribed, but the material is hardly sufficient for an accurate description of a new taxon.

Ascomycetes

The hypogeous Ascomycetes belong in two main groups. The *Elaphomycetaceae* are members of *Plectascales*, although not closely related to other families in this order. The remaining genera are generally referred to the order *Tuberales*. The genera known from Denmark, and some few others, which are likely to be found here, are included in the key.

Key

to the genera of hypogeous *Ascomycetes*

1.	Asci globose, thinwalled, spores spherical, gleba powdery at maturity	*Elaphomyces* p. 18
1.	Asci cylindrical to subglobose, spores elliptic to globose, gleba fleshy..........	2
2.	Ripe spores smooth or finely verrucose, peridium even or folded, not warty..........	10
2.	Spores verrucose, if smooth then peridium distinctly warty	3
3.	Fruit body with apical opening	4
3.	Fruit body with several openings, with basal cavity, or entire	6
4.	Gleba pallid, cavity simple or folded, lined by epithecium	*Genea* p. 29
4.	Gleba colored, cavity folded, no distinct epithecium ..	5
5.	Gleba yellowish-green to olive, spores globose	*Pachyphloeus* p. 32
5.	Gleba flesh color to ochre, spores elliptic...........	(*Gyrocratera* p. 27)
6.	Fruit body folded, with several openings	*Hydnotrya* p. 28
6.	Fruit body entire or with basal cavity...............	7
7.	Spores smooth, elliptic, peridium warty	*Balsamia* p. 36
7.	Spores sculptured	8
8.	Gleba with distinct veins, asci with 1–4 (6) spores	*Tuber* p. 37
8.	Gleba obscurely veined or homogeneous, asci with 8 spores	9
9.	Spores reticulate, fruit body small..................	*Hydnobolites* p. 49
9.	Spores echinate-spiny, fruit body large..............	*Choiromyces* p. 48
10.	Fruit body with basal cavity, spores globose.........	(*Stephensia* p. 32)
10.	Fruit body with folded walls, spores elliptic	(*Geopora* p. 27)
(10.	Fruit body with simple cavity and apical opening.....	*Sepultaria and Sarcosphaera* of *Pezizales*)

Plectascales

The order is represented among the hypogeas by the family **Elaphomycetaceae**, well distinguished from other hypogeal ascomycetes on the nature of the gleba, pulverulent when mature, and on the irregularly arranged, spherical, thinwalled asci, which burst before the spores ripen. The fruit body is covered by a loose mycelial crust impregnated with soil and litter, the cortex is well set off from the peridium, warty-spiny, the warts more or less covered by a layer of tangentially arranged, thinwalled hyphae, protruded by the tips of the warts. The inner peridium is made up of interwoven, thickwalled hyphae, separated from the gleba by a tissue of thinwalled hyphae, which also protrudes the gleba as dissepiments. The young gleba is cottony, becoming dark brown and pulverulent when mature. The asci are born on thick, curled ascogenous hyphae, they are 6–8 spored in most species. Only the genus *Elaphomyces*, and only the smaller part of the species described has been found in Denmark. For additional information see Fischer (1897) and Dodge (1929).

Elaphomyces Nees ex Fries

Key

1.	Cortex yellowish brown	2
1.	Cortex black	6
2.	Peridium pallid, not marbled	3
2.	Peridium pallid or dark, distinctly marbled	4
3.	Spores with 2–4 μ high spines	*E. granulatus* p. 18
3.	Spores with 1 μ high, coalescent spines	*E. asperulus* p. 20
4.	Peridium pale, warts on cortex rather flat	*E. reticulatus* p. 23
4.	Peridium dark, warts ± pointed	5
5.	Warts small, in beech wood	*E. variegatus* p. 22
5.	Warts prominent, tawny	*E. muricatus* p. 21
6.	Cortex with black spines protruding greyish-brown felt	*E. aculeatus* p. 24
6.	Cortex appearing almost smooth	7
7.	Cortex brittle, spores 20–25 μ	*E. uliginosus* p. 25
7.	Cortex more soft, spores 32–36 μ	*E. septatus* p. 26

Elaphomyces granulatus Fr. 1829, p. 58; emend Hollós 1911.

Syn.: *E. cervinus* (L. ex Gray) Schlect. 1824 pro parte.

Fig. 4, p. 19.

Fruit body medium to large, 2–5 cm broad, globose or frequently distinctly flattened, sometimes covered with detachable earthy crust; cortex dull pale brown (Clay Color to Cinnamon, h3), warts low, not

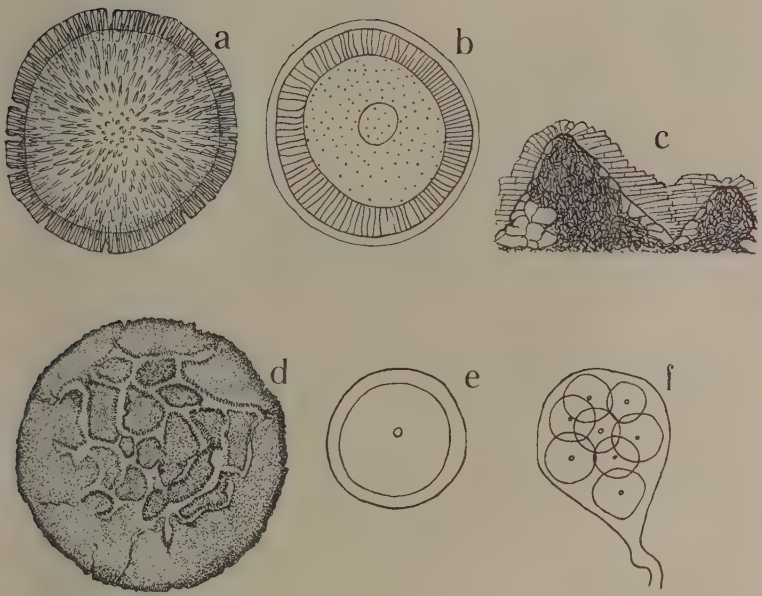

Fig. 4. *Elaphomyces granulatus*: a Ripe spore; b Unripe spore (×1100); c Section of cortex (×100). *Elaphomyces asperulus*: d Ripe spore; e Unripe spore (×1100); f Ascus (×500).

pointed; peridium moderate to rather thick, 1–3 mm, white or slightly tinged vinaceous with vinaceous or pale brownish zone towards gleba, dissepiments narrow, pallid brownish (preserved in one specimen only).

Warts 200–400 μ high, 300–400 μ broad, made up of closely interwoven, 2–4 μ broad, yellow hyphae and areas of large, fused, bright yellow to orange yellow cells, tissue of tangentially arranged, 4 μ broad hyphae among warts, and similar less regularly arranged hyphae radiating from top of almost all warts; outer part of peridium of thickwalled 2–3 μ broad hyphae, more thinwalled and broader (4 μ) in inner part, hyaline, often somewhat vinaceous towards gleba; asci 30–60 μ broad, rounded 3-4-angular, 4–8-spored; young spores covered by 2 μ thick gelatinous sheath, exospore a 4–5 μ broad, densely striate zone, ripe spores dark brown, densely spinose, spines very conspicuous, 3–4 μ high, embedded in gelatinous sheath, total diam. 23-32 μ; a few spores in some mounts with bright blue pigment in centre or blue all over.

The species is probably not very common, occuring mostly in beech wood, hypogeous.

The typification of *E. granulatus* can be regarded as rather hopeless. FRIES did not distinguish it from *E. asperulus*, and two authentic specimens from E. FRIES in the Copenhagen herbarium represent *H. asperulus* and *H. muricatus* respectively. *E. granulatus* can only be distinguished with certainty from the former of this species on microscopical characters as illustrated by HOLLÓS (1911, Pl. V).

Danish finds: PAH7472, Dæmpegård, S., June 15, 1888, leg. C. HANSEN; – Åsevang, Furesø, S., May 8, 1892, leg. JON. LANGE (M. H.); – PAH7566, Gravning, J., summer 1892, leg. BRUUN; – PAH3989, N. Feldborg Plantation, J., leg. Ø. WINGE; – ML4197, Rude Skov, S., under *Fagus*, Aug. 19, 1952.

Elaphomyces asperulus VITT. 1831, p. 69.

Syn.: *E. granulatus* FR. pro parte.

Fig. 4, p. 19.

Medium to large; fruit body up to 5 cm broad and rarely less than 2 cm broad, covered by thick crust of mycorrhiza and mycelium; cortex yellowish when fresh (Pale Orange Yellow to Cinnamon Buff, (e6–g7) turning Clay Color (h3) on drying with low and small, obscurely tri- to pentagonal, flattened or slightly pointed warts; peridium in section 1–2 mm thick on dried, ripe specimens, pallid or more often Grayish Vinaceous or Drab (c3 to near j3), often with darker zone just under the rather thin cortex; young gleba vinaceous gray (dry), dissepiments concolorous, thin.

Warts 200–300 μ high, 250–350 μ broad, central part of narrow, interwoven hyphae, outer part of poorly defined, larger cells of bright orange color, tissue between and on warts as in *E. granulatus*; peridium of thick-walled hyphae, 3 μ broad in outer part, 4–5 μ in inner part, subhyaline or more often pallid vinaceous; dissepiments of narrow hyphae with reddish vinaceous pigments; asci mostly 35–50 μ broad, 7–8-spored, more rarely with 6 spores, bursting when spores are rather small; epispore on young spores a 1–2 μ broad zone almost without striation, ripe spores large and very dark brown, diam. 28–38 μ, smaller in some specimens (25–30 μ), very densely set with 1 μ high spines, coalescent, making surface of spore appear as divided up in blocks.

Probably common, especially in coniferous wood, generally hypogeous.

VITTADINI characterized the species by the spines and the color of the peridium but these features are not constant enough to distinguish it from *E. granulatus*. DODGE (1929) found the spores of *E. asperulus* to be significantly larger than in *E. granulatus*, but only when the difference in

spore sculpture is taken into account is a clear separation possible. It is a peculiar fact, that this outstanding character, well illustrated by HOLLÓS (1911, Pl. V), has been overlooked by later authors. The unripe spores depicted by HAWKER (1954, Fig. 3h) seem to represent *E. asperulus* and the ripe spore (Fig. 3i) may do so too. *E. asperulus* is more common than *E. granulatus*, and it is a pity that it seems necessary to employ the names as done here. However, HOLLÓS has studied authentic material of *H. asperulus*, and is at any rate the first to demonstrate a convincing difference between the species, so it seems unavoidable to follow his emendation.

Danish finds: Als 1855, leg. P. LYMAN; – Tisvilde, S., Oct. 24, 1878, leg. E. ROSTRUP (cp. ROSTRUP 1895); – ibid., March 1903, leg. FRYDENSBERG; – Stendalsgårds Plantage, J., Oct. 1881; – ibid., Sept. 5, 1905, both leg. E. ROSTRUP; – Gribskov, S., Sept. 21, 1913, leg. HAGERUP, all in M.H. – PAH7444, Rude Skov, S., April, 1906, leg. Ø. WINGE; – 7546, ibid., June, 1936, leg. C. TRESCHOW; – PAH3989, N. Feldborg Plantage, J., Sept. 1931; – 3993 ibid., both leg. Ø. WINGE; – ML675, Munkebjerg by Vejle, J., Aug. 22, 1940, leg. J. E. & M. LANGE; – ML676, Tisvilde, S., Oct. 14, 1945.

Elaphomyces muricatus FR. 1829, p. 59.

Fruit body 2–5 cm broad, often distinctly lobed; cortex rich brown (Tawny to Cinnamon Brown, h1–g8), clad with conspicuous, 3- or 4-angular pointed warts, 0.5–2 mm high, rather thick; peridium 3 mm thick or more, marbled, yellowish brown under cortex, Dark Maroon to Bone Brown (c2) with narrow, pinkish veins; gleba with pinkish, narrow dissepiments.

Spines 500–1000 μ broad, 500–1500 μ high, of densely interwoven, yellowish brown hyphae, 3–4 μ broad; a tissue of tangentially arranged, subhyaline septate hyphae, 4–5 μ broad between bases of spines; peridium of interwoven hyphae, yellowish near cortex, 3–4 μ broad, subhyaline with $\pm$ vinaceous cast within, almost compact, slightly less so and more vinaceous in narrow zones forming reticulum; spores 18–25 μ diam., dark brown when ripe, densely echinate, spines about 1.5–2.5 μ high, endospore 6–7 μ thick; asci 4–8-spored, 25–40 μ broad, globose or obscurely angular, stipitate.

Not uncommon, in sprucewood, hypogeous, often under deep moss carpet, parasitised by *Cordyceps parasiticus*.

FRIES' original description of *E. muricatus* leaves little hope of clearing up the original concept of the species, as it probably covers the following species as well. It is believed to be the species described by DODGE (1929)

under this name. The large, deep brown spines distinguish it from other Danish forms of the group. *E. muricatus* as described by HAWKER (1954) is recorded exclusively from deciduous woods and belongs in *E. variegatus* (see below).

Danish finds: Nørremølle Plantation, J., Oct. 10, 1903, leg. J. LIND (M.H.); – PAH7473, Teglstrup Hegn, S., Sept. 9, 1905, leg. Ø. WINGE; – Holmegårds Mose, S., June, 1935, leg. LÆSSØE ENGBERG (M.H.); – PAH7607, Tarm Plantation, J., Nov. 1944, leg. K. BÜLOW; – ML2004, Maglemose, Grib Skov, S., Oct. 13, 1947; – ML2570, Tisvilde Hegn, S., Oct. 10, 1948; – ibid. Aug. 1954, leg. BERTEL HANSEN.

Elaphomyces variegatus VITT. 1831, p. 68.
Fig. 5, p. 23.

Small to medium; fruit body 0.5 cm broad, almost globose to ± flattened, surrounded by a poorly organised, not easily detachable earth crust; cortex Clay Color to Tawny (h3) or frequently more yellowish, especially when young, densely set with fine, pointed warts with 4–5 angular base; peridium 2 mm thick in section, cortex thin, yellow, peridium marbled, Bistre to Diamine Brown (c3–o1), paler towards cortex, Army Brown to Fawn Color (j2–3), with Vinaceous Buff, narrow veins; gleba blackish brown, with dissepiments Fawn Color to Vinaceous Buff, almost disappearing at maturity.

Warts 300 μ high or more, 250–300 μ broad, of yellow, closely interwoven hyphae, 2–3 μ broad; tangentially arranged hyphae between lower part of warts subhyaline, 4–5 μ broad; outer part of peridium sometimes yellowish but whole peridium with network of distinctly vinaceous tissue with airspaces, while remaining part almost compact, of interwoven, thickwalled hyphae, 3–4 μ broad, 4–6 μ in inner part, subhyaline to pallid vinaceous; asci with 4–7, rarely 8 spores, obscurely angular, 18–40 μ broad, stipitate; young spores with a 3 μ broad, finely striate outer layer, ripe spores moderately dark brown, 15–25 μ broad, echinate, spines 1.5–2 μ high; capillitium scanty, of 1.5 μ broad hyphae, ascogenous hyphae curled, about 4 μ broad.

The most common species of the genus in Denmark, found in beech wood on acid soil, very often partly exposed. Fresh specimens with both unripe asci and ripe spores are still frequent in January, after severe frost.

Very similar to *E. muricatus*, and may well be regarded as a subspecies, characterized by smaller size, lower spines, slightly more dull colors and most often smaller and paler spores. But also the character of the crust seems to separate the species, and it has not been difficult to keep them

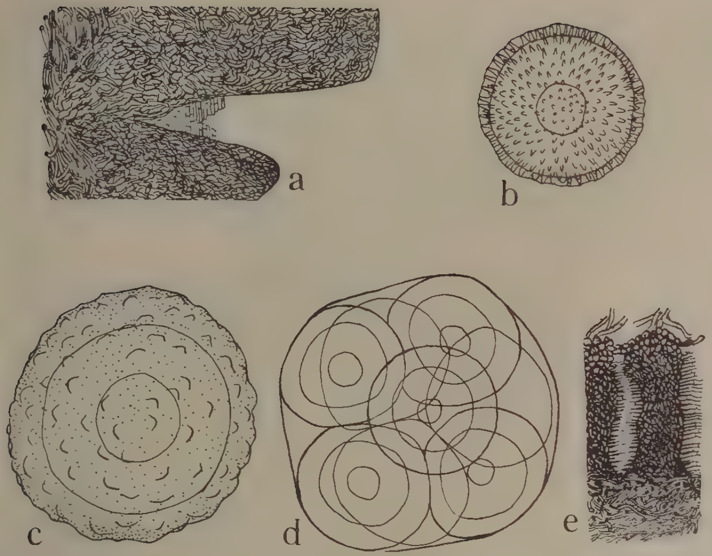

Fig. 5. *Elaphomyces variegatus*: a Section of cortex (×100); b Spore (×1100). *Elaphomyces septatus*: c Spore (×1100); d Ascus (×500); e Section of cortex (×100).

apart from each other in the material studied. VITTADINI did not separate *E. variegatus* and *E. muricatus*, and the nomenclatorial status of the species may be dubious; however, DODGE (1929) applied the name to a small species with rather small spores. Already CORDA conceived the two taxa as done here (STURM, Flora III, 19–20 Tab. 7 & 9) but regarded both as varieties of "*Elaphomyces vulgaris*".

Danish finds: Numerous collections from Sjælland, Fyn and Jylland.

Elaphomyces reticulatus VITT. 1842, p. 74.

Syn.: *E. variegatus* var. *pallens* TUL. 1851; *E. asperulus* × *E. variegatus*?

Fruit body 1–3 cm broad, regular, almost globose; cortex with low and flattened, 4–5 angular, very uniform, pyramidal warts, Tawny Olive to Clay Color or Buckthorn Brown (h2–3); peridium 1–2 mm thick, obscurely marbled, pallid vinaceous with almost white to pinkish veins, inner side of peridium pallid when spores are removed and appearing marbled like peridium in section; gleba almost black with pinkish dissepiments.

Warts 200–250 μ high, 200–400 μ broad, of compactly interwoven,

yellow hyphae with tangentially arranged hyphae between the warts and similar cells sometimes radiating from top; peridium of interwoven, thickwalled hyphae, 3 μ broad, 4–6 μ in inner part, pallid vinaceous tinged especially in veins; asci not seen; spores dark brown, diam. 19–28 μ, echinate, spines 2–2.5 μ high.

Probably not common, in deciduous wood on rich soil, hypogeous. One find (PAH7550) from lawn in garden, 30 cm under surface (cp. BUCHWALD, 1932).

Very close to *E. variegatus*, but distinguished in the field on the flattened warts, and the paler peridium. It may also be a distinguishing character, that earthy crust seems almost absent. Configuration and color of cortex recall very much *E. granulatus*. The specimens agree very well with VITTADINI's description and figure (1842, Tab. III, Fig. IV) except for the size of the spores which VITTADINI and also DODGE give as rather small, but spore size is probably not a very stable character in this group, where the number of spores per ascus seems to vary much from specimen to specimen. TULASNE's *E. variegatus* var. *pallens* is almost certainly synonymous.

HAWKER (1954, p. 449) mentions a form of *E. granulatus* with faintly marbled peridium which she presumes may be a hybrid between *E. granulatus* (as conceived by her) and *E. variegatus* (*E. muricatus* sensu HAWKER). This may very well be substantiated if hybrids exist in this group at all.

Danish finds: Nørager, S., spring 1881, leg. MOLTKE (M.H.); – PAH7550, Bonderup, S., May 6, 1932, leg. LA COUR; – PAH7575, Purlund by Køge, S., leg. M. P. CHRISTIANSEN; – ML4004, Roden Skov, Lolland, Sept. 4, 1951.

Elaphomyces aculeatus VITT. 1831, p. 70.

Fruit body 1–2 cm broad, cortex with fine, black pointed warts protruding a grayish brown, felty outer layer; peridium dark in outer part under black inner cortex, inner peridium pallid.

Cortex about 300–400 μ thick, made up of pointed warts, confluent at base, of interwoven hyphae with very thick, dark brown to black walls, and a very narrow lumen; tissue between warts of tangentially arranged hyphae, 4 μ broad, septate, pale brown, giving rise to loosely woven hyphae covering the fruit body; outer peridium of thickwalled, interwoven, brown 4 μ broad, hyphae, paler hyphae in inner part; spores 14–18 μ diam., covered by spines, 1 μ high.

The above description is drawn from the only Danish collection of

the species, preserved in alcohol, a few fragments of cortex also dried. It seems confined to calcareous soil, and is probably very rare in Denmark.

Danish find: Allindelille, S., June 10, 1871, (M.H., mislabelled *E. granulatus*). The entire provenue of the first Danish "Truffel-excursion" (vide SAMSØE LUND, 1872). A later record from the same locality (BUCHWALD, 1929) is probably a mistake, the preserved specimens from the excursion in question (the total provenue of the second Danish "Truffel-excursion") is correctly labelled *E. variegatus.*

Elaphomyces uliginosus HESSE 1894, p. 67.

Syn.: *Elaphomyces anthracinus* VITT. 1831?

Fruit body 2–3 cm broad, slightly flattened with low depressions, covered by dark, firm earthy crust of blackned mycorrhiza and scanty dark reddish brown mycelium; cortex on fully ripe specimens almost black with a flush of Bone Brown (c 2), obscurely and finely warty, in most specimens with one large smoth well delimited spot with greenish discoloring mycelium, brittle and hard, separable from peridium; peridium 1.5–2 mm thick, pale silvery gray when fresh but soon turning slate gray, soft; ripe gleba pulverulent, black with a distinct olivaceous sheen.

Odor not distinctive.

Cortex 250–350 μ thick with broad flat warts, protruding part 100 μ high, 200 μ broad, made up of pseudoparenchymatic tissue, dark sepia, walls 1–2 μ thick, subparallel hyphae between warts 4–5 μ broad and but slightly paler sepia; peridium well set of from cortex, hyphae pale brownish hyaline, thickwalled, 3–4 μ broad in outer part, more loosely woven and 6–7 μ broad within; spores 21–25 μ broad, dark brown to almost black, densely set with very low spines; capillitium scanty, of 2 μ broad hyaline hyphae incrusted with olivaceous pigment; asci not seen.

Only found once in Denmark, 4 fruitbodies under beech, deeply buried in moderately firm soil, growing together with *E. variegatus* and *E. asperulus.*

The specimens are referred to *E. uliginosus* after having been compared with an exsiccatum in ALLESCHER & SCHNABL, Fungi Bavarici, and found identical in all details with this material. Also the original description covers quite well, but does not mention the green spot on the peridium, which however is absent in two of my four specimens. The separable cortex seems to be an outstanding character which also is mentioned by HESSE. *E. uliginosus* is generally considered identical with *E. anthracinus* VITT. which species, however, is described as somewhat smaller, and as it

seems constantly with smaller and more smooth spores. *E. maculatus* VITT. differs in much larger spores.

Danish finds: ML4700, Grib Skov, S., March 20, 1956.

Elaphomyces septatus VITT. 1831, p. 67.

Fig. 5, p. 23.

Fruit body 1.2–2 cm broad, globose to slightly flattened, relatively soft, surrounded by rather close weft of brownish and, in places, greenish mycelium; cortex velvety smooth, black, but with green patches of mycelium firmly attached, black in section, thin; peridium 3 mm thick, soft-fibrillose, pallid, darker just under cortex; gleba cottony, white, becoming grayish brown from ripening spores,

Smell faint, like *Scleroderma*.

Cortex 150–200 μ thick, covered by flexuose hyphae, 6 μ thick, hyaline or incrusted with brown pigment; cortex proper of tangentially arranged hyphae, 4 μ thick, thickwalled, dark brown, broken up by areas of irregular pseudoparenchyma of 4–8 μ broad cells and appearing as black, imbedded spines; peridium of densely interwoven hyphae, 2–3 μ broad, near the gleba very thickwalled with intercellular, dark brown pigments; gleba a loose weft of 2 μ broad, hyaline hyphae, ascogenous hyphae curled, 6 μ broad; asci about 75–90 μ broad, globose-angular, 8-spored; spores globose, 32–36 μ diam., almost fully developed before the asci burst, dark brown, epispore 4 μ thick, striate, leaving surface punctate, surface of ripening spores also with coarser, verrucose-patchy sculpture.

Only found once in Denmark, hypogeous in clayey soil under old oak and beech.

The species is well depicted by HOLLÓS (1911, Tab. II, Fig. 35). It is closely related to *E. maculatus* VITT. but differs from this species through slightly smaller spores and the absence of well delimited, round, green depressed maculae. *E. anthracinus* VITT. and *E. leveillei* TUL. has smaller spores.

Danish find: ML4003, Marienlyst by Vordingborg, S., Sept. 5, 1951. (cp. M. LANGE 1953 sub *E. maculatus*).

Tuberales

The numerous genera of hypogeous ascomycetes with non-pulverulent gleba are here classified in one order. FISCHER (1938) referred *Terfeziaceae*

to *Plectascales* but this seems not supported by most recent authors and further studies on the development and cytology of the species are necessary to clear this question as well as the delimitation of the remaining families of *Tuberales*, which, on their side are in need of a clearer definition. The classification proposed by KNAPP (1950–52) is followed, when distributing the Danish genera on four families, viz. *Hydnotryaceae* with asci cylindrical or clavate in distinct hymenium without epithecium, lining open cavities in the fruit body, *Geneaceae* similar, but with distinct epithecium, *Tuberaceae* with clavate to globose asci and subsolid gleba, and *Terfeziaceae* with chambered fruit body without distinct veins, and clavate to globose, irregularly arranged asci. It is generally agreed that some or all genera of *Tuberales* have developed from *Pezizales* but it is highly probable that the order is polyphyletic, and thus in need of a drastic rearrangement. If the type of infolding in young specimens is made the leading character, this may lead even to a split of the genus *Tuber* itself. It is worth while noticing, that the most pezizoid genera also are characterized by the most simple sculpturing of the spore. The key to the genera is found on p. 17.

Hydnotryaceae nom. nov.

(*Pseudotuberaceae* KNAPP 1950, emend. 1952)

Only the genus *Hydnotrya* is reported from Denmark. The genera *Gyrocratera* and *Geopora* are known from neighbouring areas and may well be found in Denmark. The name *Pseudotuberaceae* KNAPP is untenable under the present international code. The name *Hydnotryaceae* is proposed, and the genus *Hydnotrya* considered the type genus.

Geopora HARKNESS

Fruit body hairy, irregularly folded with openings to open cavities. Spores smooth. *G. schackii* HENN. is known from Sweden (NANNFELDT, 1946).

Gyrocratera P. HENNINGS

Fruit body with one or more openings to a simple or folded cavity, smooth; spores brown, verrucose. *G. ploettneriana* HENN. is known from Sweden (NANNFELDT, 1936).

Hydnotrya BERKELEY & BROOME

Fruit body with wrinkled-folded surface with several openings leading to hollow labyrinthine open channels, lined by hymenium. Asci clavate-cylindric with coarsely-warty spherical dark brown spores.

Hydnotrya tulasnei (BERK.) BERK. & BR. 1846, p. 78.

Hydnobolites tulasnei BERK. & BR. 1844.

Fruit body 0.5–7 cm broad, surface in small specimens almost entire, with a few, small holes, but generally wrinkled-lobed and distinctly infolded; peridium Ochraceous Salmon (e8) with fine white puberulence when young, scurfy-smooth and much darker when maturing, Dark Vinaceous Brown to Maroon (c1–2); gleba with irregular folded, open veins, springing from holes or grooves on surface, almost concolorous, with paler puberulence lining the veins, young tissues becoming darker when bruised or where bored by insects.

Smell faint, sweetish.

Peridium coated with short, obtuse hairs (30–40 × 8–10 μ) hyaline when young, becoming brown or disappearing in age, springing from outer, pseudoparenchymatic layer, 3–4 cells deep, cells 10–35 μ broad, walls thickened, brownish; main layer of interwoven hyphae, 6–8 μ broad; gleba of similar hyphae, young hymenium a palisade of pale septate paraphyses, 6 μ broad, tips slightly broader, becoming prolonged, flexuose and darker when mature; asci obtuse clavate to subcylindric, 170–235 × 40–75 μ, in one layer or often more irregularly arranged, especially in young stages, 8-spored, spores uniseriate to more or less distinctly biseriate, of rich red-brown color, almost globose, with large, irregular warts, 33–38 μ broad incl. sculpture.

Common, especially in deciduous wood, rarely under conifers, hypogeous or partly exposed, often several specimens closely nested.

The name *Hydnotrya carnea* (CORDA) ZOBEL is often ascribed to large, strongly folded, pale forms. This species should primarily be distinguished on uniseriate spores and the asci in one level, while *H. tulasnei* should have biseriate spores and many subhymenial asci (vide ZOBEL, 1854). BUCHOLZ found forms with intermediary characters (*H. intermedius* (BUCH.)). My study of the available material does not substantiate the differential value of the character, as both cylindric and broadly clavate asci most often occur in the same fruit body. This corresponds quite well to the results obtained by SOEHNER (1942) who tried to define three species on

the characters of the asci, but had to place most of his large material in "*H. intermedius*". However, the species is very variable, and it might possibly be divided in two or more taxa on size and color of fruit body, paired with characters of the outer peridium. I prefer to abstain from this at present. An eventual division of the taxon will raise a question of nomenclature, as the authentic material seems somewhat controversial, not covering the original descriptions (vide i. a. ZOBEL, 1854, p. 62).

Danish finds: More than 40 collections from J., F. and S. (cp. BUCHWALD, 1943).

Geneaceae

Only the genus *Genea* is represented in Denmark and neighbouring areas. It is, however, not impossible that also *Genabea* and *Myrmecocystis*, both with more complex fruit bodies, may grow in Denmark.

Genea VITTADINI

Fruit body globose or lobed, with distinct apical opening and basal mycelial tuft, hollow, containing one chamber with wrinkled walls or simple; asci cylindrical, spores elliptic, hyaline, verrucose; paraphyses forming epithecium similar to outer peridium.

Key

1. Peridium densely set with brown hairs .... *G. hispidula* p. 29
1. Peridium black, warty, without hairs 2
2. Spores with regularly arranged, blunt warts.......... *G. verrucosa* p. 31
2. Spores with large, irregularly arranged warts......... *G. klotzschii* p. 31

Genea hispidula BERK. in TUL. 1851, p. 121.

Fig. 6, p. 30.

Fruit body 0.4–1.2 cm broad, depressed globose or slightly lobed, mouth broadly elliptical to slit-like, depressed; peridium dark brown with fine warts and covered by felt of paler or darker brown hairs, distinct tuft of brown mycelia at base; inner side of hollow fruit body even or slightly lobed, hairs and warts as on outside, but hardly as well developed; flesh 0.05 cm thick, whitish, when ripe watery gray with a faint bluish sheen.

Outer peridium 200–350 μ thick, external layer of 1–2 rows of angular, dark brown cells about 40 μ broad, giving rise to dark, thickwalled,

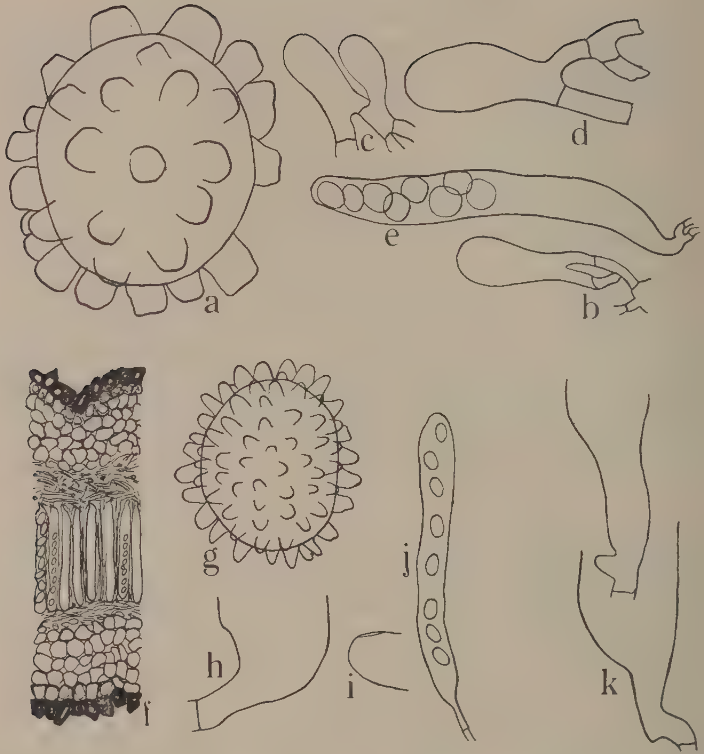

Fig. 6. *Genea klotzschii*: a Spore (×1100); b–d Young asci (b ×500, c, d ×1100); e Nearly ripe ascus (×250). *Genea verrucosa*: f Section of peridium and hymenium (×50); g Spore (×1100); h–i Base and top of ascus (×500); j Nearly ripe ascus (×250). *Genea hispidula*: k Ascus bases (×500).

septate, unbranched or sparingly branched hairs, up to 600 μ long, 15–18 μ broad at base, 5–7 μ at top; main layer of subhyalin pseudoparenchyma over a comparatively narrow filamentous layer; inner peridium with bark as on the outside over rather few layers of pseudoparenchyma, epithecium distinct; hymenium with densely woven paraphyses, 3–4 μ broad, and single layer of asci, 250–300 × 25–35 μ, cylindrical, constricted between uniseriate spores, base spur-like developed; spores broadly elliptical, 32–42 × 26–32 μ including 3 μ high, broadly rounded papillae.

Common, in deciduous wood, generally more or less exposed. Very easily distinguished on the conspicuous long brown hairs.

Danish finds: More than 30 collections from S. and J. (cp. M. Lange, 1948).

Genea verrucosa VITT. 1831, p. 28.

Fig. 6, p. 30.

Fruit body 0.3–1.2 cm broad, generally ± distinctly flattened, almost regular to somewhat lobed in larger specimens, mouth circular to slit-like, somewhat depressed, 0.1–0.25 cm long; peridium black with small pyramidal warts, distinct tuft of brown mycelia at base; innerside of hollow fruitbody similar to outer peridium, sometimes simple, in larger specimens irregularly folded; peridium rather thin in section, more or less thickened at base and in the folds. No distinct smell.

Outer peridium 300–400 μ thick, including warts up to 100 μ high, external layer of 1–2 rows of angular cells 30–90 μ broad, with thick brown walls and small lumen, then 3–6 layers of pseudoparenchymatic tissue, cells 30–40 μ broad, subhyalin, over a 75–150 μ thick filamentous layer of 4–5 μ broad hyphae; inner peridium 250–300 μ, without distinct warts, 1–2 layers of dark brown cells over pseudoparenchymatic tissue, epithecium proper very narrow; paraphyses 4 μ broad, septate, asci in single layer, 200–310 × 25–33 μ, cylindrical, ± constricted between ripe spores, base without crozier; spores uniseriate, broadly elliptical, 25–36 × 22–28 μ, incl. sculpture of 2–4 μ high papillae.

Probably not uncommon. Found hypogeous or slightly protruding in clayey soil along paths in deciduous woods.

Most specimens seen are small and globose-flattened, but larger specimens with folded walls are identical microscopically, except for a somewhat thicker peridium.

Danish finds: Purreskov, Lundeborg, F., Aug. 1950, 1954 (ML3225, 3300, 4590); – Rude Skov, S., Aug.–Sept. 1952–53 (ML4174, 4187–90, 4206, 4233–34, 4268, 4341, 4411, 4436); – Farum Lillevang, S., Aug. 1952 (ML4224–26).

Genea klotzschii BERK. & Br. 1846, p. 78.

Fig. 6, p. 30.

Only known to me from a single collection of two rather large fruit bodies, macroscopically similar to large specimens of *G. verrucosa* but with walls more distinctly folded and rather much thickened in places.

The specimens differ microscopically from *G. verrucosa* through presence of a single layer of thickwalled cells between the pseudoparenchyma and the filamentous layer in the 350–450 μ thick outer peridium, slightly larger asci (260–340 × 35–40 μ) with complicated basal

structure, and larger spores with few broad warts (42–51 × 32–41 μ including 4–5 μ high warts, 32–41 × 25–34 μ without warts).

The present specimens is referred to *Genea klotzschii* on its spore characters, which are exactly as illustrated i. a. by HAWKER (1954, Fig. 7g) and which separate it well from *G. verrucosa* and *G. sphaerica* TUL., both with less coarse spore sculpture. However, the complicated ascus base is like that which is found in *G. sphaerica* (cp. TULASNE, 1851) and the specimen lacks the white mycelium generally ascribed to *G. klotzschii*. Furthermore, *G. klotzschii* and especially *G. sphaerica* are described with much more solid fruit bodies.

Danish find: ML4019, Allindelille, S., deciduous mixed wood, on clayey soil, Sept. 9, 1951.

Tuberaceae

Fruit body solid, or with an apical or basal cavity; peridium smooth or warty, rarely hairy; gleba with a few, open ducts or in mature specimens most often solid, with the infolded ducts seen as pallid venae externae, filled with interwoven paraphysal tissue, the trama forming another system of lines, venae internae. Hymenium rarely forming a continuous palisade but much broken up, or the ripe asci almost evenly distributed in gleba; asci clavate to subglobose.

The genera currently referred to *Tuberaceae* are probably not all truly related. *Pachyphloeus*, with apical opening and blackish, warty peridium seems in many ways more related to *Geneaceae*, in spite of the poorly developed epithecium, and *Balsamia*, with smooth spores reminding of certain *Pezizales*, may again be referred to the vicinity of *Hydnotryaceae*, or referred to its own family as indicated by FISCHER (1897). *Stephensia*, with an irregular, large basal cavity, is the only North European genus not yet encountered in Denmark.

Pachyphloeus TULASNE

Fruit body globose or lobed, black, or flushed with yellowish olive, with a basal mycelial tuft, and a more or less distinct apical pore leading into a few short, open veins lined by incomplete hymenium in a yellowish-olive gleba. Asci clavate, with 8 globose, spiny-warty spores.

The asci of *P. melanoxanthus* turn blue with Iodine; a quite exceptional pezizaceous character.

Both SOEHNER (1936) and HAWKER (1954) recognize three species of

Pachyphloeus from the European area. The same three species are found in Denmark, although none of them are common here. Other European species, mentioned in older literature, are of a rather dubious status.

The American species *P. virescens* GILKEY, with globose asci, seems closely related to the European forms and should be sought for in Europe.

Key

1. Peridium distinctly warty, spores spiny.............. 2
1. Peridium scurfy-smooth, spores warty .... *P. conglomeratus* p. 35
2. Spores with spines 2.5–3 μ long .... *P. melanoxanthus* p. 33
2. Spores with very low, densely set spines............. *P. citrinus* p. 34

Pachyphloeus melanoxanthus (BERK.) TUL. 1844, p. 61.

Syn.: *Choiromyces melanoxanthus* BERK. 1844.

Fig. 7, p. 34.

Fruit body 0.5–1.5 cm broad, almost globose, with a small basal tuft of mycelia and a distinct apical ostiolum, circular, 2–3 mm broad, or slit-like and up to 5 mm long; peridium almost black when ripe, olive or more yellowish when young, covered by coarse pyramide-shaped warts, up to 15 mm broad, dark brown to black in section; ostiolum finely felty from yellow-green hairs; gleba with few, open veins radiating from mouth, veins Honey Yellow to Light Yellowish Olive (f7–8), trama proper darker, Olive (f4).

Peridium 200–300 μ thick with 250 μ high warts, outer layer and warts of large-celled pseudoparenchyma of deep vinaceous brown color, inner layer well distinguished, of pale yellowish hyphae; hymenium ± regular, protruded by pale yellowish hairs which fill out the veins; trama here and there with deep yellow pigments; asci clavate-sackshaped, faintly but distinctly blue all over in Iodine, 100–160 × 35–55 μ, 8 spores in 2 rows or more irregular; spores globose, 17–23 μ diam., including sculpture of prominent spines 2.5–3 μ long, ripe spores pale brown.

Probably uncommon. Found under leaves or hypogeous in deciduous wood on rich soil.

The coarse spines on the spores, and the deep colored cells of the peridium distinguish this species from the following.

Danish finds: Folehave Skov, S., Sept. 1905, leg. F. RIISE (cp. ROSENVINGE 1906); – ML4137, Regnstruplund by Jyderup, S., Aug. 15, 1952; – ML4235, Vintersbølle Skov by Vordingborg, S., Sept. 27, 1952; – ABK4, Fussingø by Randers, J., Aug. 10, 1953; – ML4426, Krogenberg Hegn, S., Sept. 9, 1953; – ABK51, Hvidding Krat, J., Sept. 18, 1954.

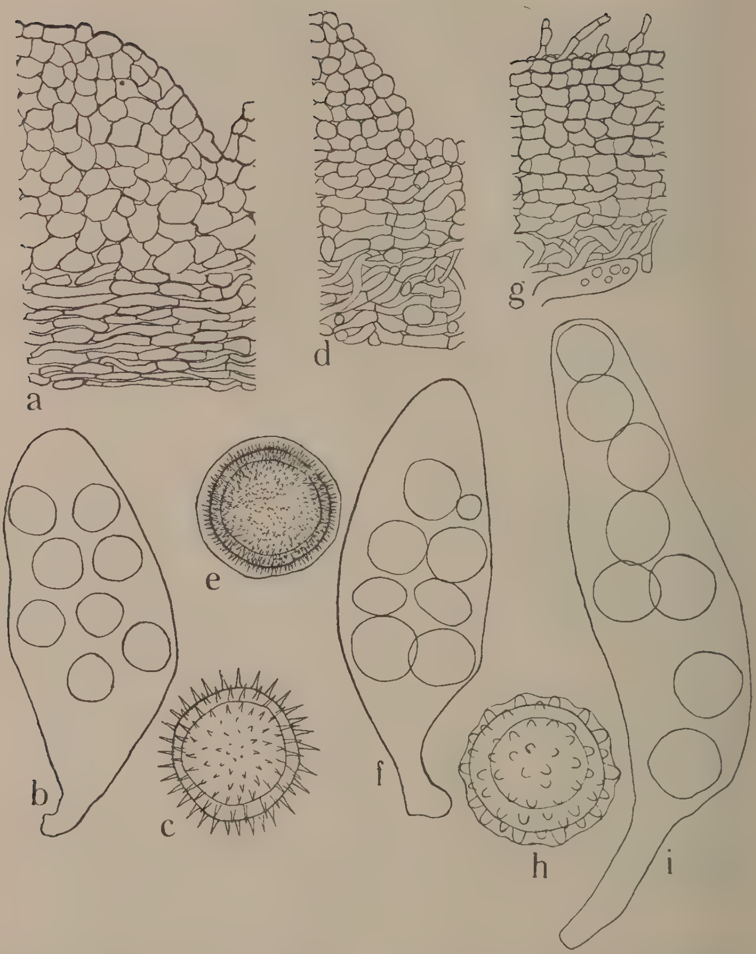

Fig. 7 *Pachyphloeus melanoxanthus* (a–c); *Pachyphloeus citrinus* (d–f), and *Pachyphloeus conglomeratus* (g–i). Section of peridium (×100); Asci (×500); Spores (×1100).

Pachyphloeus citrinus Berk. & Br. 1846, p. 79.

Fig. 7, p. 34.

Fruitbody 0.5–2.2 cm, almost globose, sometimes lobed, ostiolum distinct or sometimes obscure; peridium covered with 0.6–1.0 mm broad, low, black warts, tinged faintly greenish between warts and in folds, and

here faintly tomentose (sub lente); peridium dark in section; gleba with not too well defined veins, Parrot Green to Dark Greenish Olive, veins Olive Yellow.

Peridium 250 μ thick, with warts about 200 μ high, warts and 3–4 outer layers of peridium pseudoparenchymatic, brown in KOH and Iodine, main layer of yellowish, inflated cells, more fibrillose towards gleba; gleba of inflated hyphae, pale yellowish, in places dark yellow; asci 85–150 × 40–60 μ, not blue in Iodine, sack-shaped clavate, often curved, with short stipes; 8 spores in two rows or irregular, but not uniseriate in specimens studied, globose, diam. 17–21 μ, including dense sculpture of low, fine spines covered by gelatinous sheath, long remaining hyaline, at last yellowish.

Not common, found in deciduous wood, hypogeous or slightly protruding.

Well distinguished from the other species of the genus through its spore characters, and the structure of the peridium.

Danish finds: ML4336, Rude Skov, S., Aug. 9, 1953; – ABK8, Fladbro by Randers, J., Aug. 17, 1953; – ML4447, Kelleris Hegn, S., Sept. 9, 1953.

Pachyphloeus conglomeratus BERK. & BR. 1846, p. 80.

Syn.: *Cryptica lutea* HESSE 1894, *Pachyphloeus luteus* (HESSE) FISCHER 1897.

Fig. 7, p. 34.

Fruit body 0.8–1.2 cm broad, irregularly globose, more or less strongly lobed, ostiolum small or sometimes indistinct; peridium dark brown, smooth, rarely with inconspicuous warts, a few yellowish, felty fibrillose stripes or spots seen in all specimens, these parts sometimes slightly depressed; ostiolum yellowish olive, gleba muddled brownish yellow to pale olive or even almost Wood Brown (06), with a few, open, yellowish to brownish veins.

Peridium 200–500 μ thick, in places more or less densely set with brown hairs, main part of peridium pseudoparenchymatic, outer 1–4 cell layers dark brown, main portion yellow (pale brown when revived), inconspicuous layer of more narrow cells towards gleba; gleba of hyaline or pale yellowish ± inflated hyphae, 8–10 μ broad; asci 150–215 × 32–58 μ, not colored by Iodine; spores uniseriate or irregular arranged, globose, 21–23.5 μ including sculpture of scattered, blunt spines covered by gelatinous sheath, long remaining hyaline but yellowish brown when fully ripe.

Not common, in similar places as the two previous species, sometimes even found together with them.

Unripe specimens can be distinguished microscopically from *P. melanoxanthus* on the brownish-yellow, not vinaceous brown, peridium; ripe specimens are well distinguished from both other species on the lack of warts on the peridium and on the spore characters.

Danish finds: ML4196, Rude Skov, S., Aug. 19, 1952; – ML4223, Uggeløse Skov, S., Aug. 24, 1952, leg. BREGNHØJ LARSEN; – ML4415, Krogenberg Hegn, S., Sept. 6, 1953; – ML4427–28, ibid., Sept. 9, 1953.

Balsamia VITTADINI

Fruit body with warty peridium and gleba with narrow, open chambers. Asci 8-spored; spores elliptic, almost hyaline, smooth.

Balsamia platyspora BERK. 1844, p. 358.
Fig. 8, p. 37.

Fruit body up to 1.8 cm broad, 1 cm high, regular or slightly lobed, with or without a few deep folds; peridium set with dark brown warts (Bay, j4), paler between warts (Tawny – Ochraceous Tawny, g1–2), some specimens with a circular groove, 2 mm broad; no distinct mycelial tuft; gleba white, with few, open, narrow veins; texture firm, dry.

Smell strong and offensive.

Peridium with 100–300 μ high warts, pseudoparenchymatic, of thick-walled, brown 25–40 μ broad cells; below the warts a 100 μ broad layer of almost hyalin tissue, becoming fibrillose towards the gleba which is made up of 5 μ broad, interwoven hyphae, forming palisade of septate, 4–6 μ broad paraphyses, along the open veins; asci evenly distributed in gleba, broadly elliptic, 50–70 × 30–45 μ, with a 5–25 μ long, hooked stipe, plasma in unripe asci cherry red in Iodine; 8-spored, spores irregularly arranged, smooth, elliptic, broadly rounded in both ends, 17–24 × 10.5–15 μ, with one large and several small oildrops, long remaining uncolored, very pale brown when fully mature.

Only found once in Denmark, in rather rich soil in old garden.

The present species is easily distinguished from *Balsamia vulgaris* VITT. on the shorter spores, while it is more doubtful whether or not it can be distinguished from *B. fragiformis* TUL. HAWKER finds the differential characters to be short-stiped asci, and narrow sinuous veins in *B. platy-*

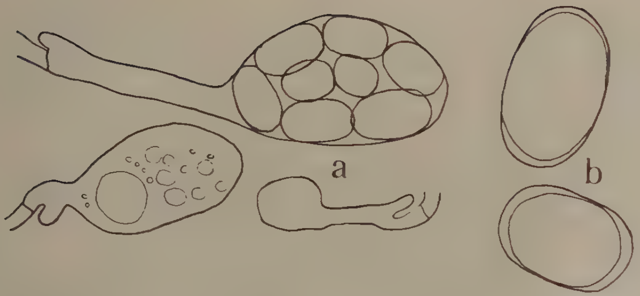

Fig. 8. *Balsamia platyspora*: a Two young and one mature ascus (×500); b Two ripe spores (×1100).

spora, but the present specimen has both long- and short-stiped asci, and TULASNE's figure of *B. fragiformis* shows narrow, sinuous veins, not small angular chambers as given by HAWKER. *Balsamia polysperma* VITT. 1831 may be an older synonym.

Danish find: ABK7, Gl. Have, Fussingø by Randers, J., Aug. 9, 1953.

Tuber MICHELI ex FRIES

The genus is well characterized by the globose-sackshaped asci with 1–4 (rarely up to 7) spores, and the solid, venose gleba. The majority of the species has large, reticulate spores, while spinose spores are met with more rarely. The venation seems to differ in the genus, as some species have veins springing from the whole periphery, while in others they spring from the base (cp. MALENÇON, 1938). The peridium is very variable in its development, thick and with big black warts or smooth and pale. The outer layer is in the latter group often developed as a pseudoparenchyma of isodiametric cells. The peridial characters should be studied on mature specimens, as they change considerably during the development.

Key

1. Spores spiny .... *T. rufum* p. 38
1. Spores reticulate 2
2. Peridium black, warty .... *T. aestivum* p. 40
2. Peridium paler 3
3. Fruit body with deep basal cavity .... *T. excavatum* p. 41
3. Fruit body entire 4
4. Fruit body yellow, hard, finely warty .... *T. scruposum* p. 41
4. Fruit body pallid or brown, more soft 5

5. Outer main part of peridium distinctly pseudoparenchymatic 6
5. Outer part of peridium not distinctly pseudoparenchymatic 9
6. Spores globose, peridium set with hairs .... *T. puberulum* p. 42
6. Spores elliptic 7
7. Spores short, with wide meshes, peridium dark, obscurely verrucose .... *T. foetidum* p. 45
7. Peridium long remaining pallid, spores with rather narrow meshes 8
8. Peridium distinct from gleba, inner peridium of narrow hyphae .... *T. rapaeodorum* p. 43
8. Peridium not well set of from gleba, inner peridium of broader hyphae .... *T. borchii* p. 44
9. Fruit body very small to medium .... *T. maculatum* p. 46
9. Fruit body large, pallid, veins many .... *T.* sp. p. 47

Tuber rufum PICO ex FR. 1823, p. 292.

Syn.: *Tuber ferrugineum* VITT. 1831, *T. nitidum* VITT. 1831, *T. rutilum* HESSE 1894. *T. candidum* HARKN. 1899.

Fig. 9, p. 39.

Fruit body 0.4–2.5 cm broad, almost globose or slightly lobed, surface scurfy, in some specimens with flat, low warts, in other almost smooth, Cinnamon Brown, Russet, Clay Color (h1–3, g8, j4) or these colors .. mottled, rarely paler (Cinnamon Buff, g7, or more yellowish); almost all specimens with a small basal depression where the peridium is distinctly felty and pale; gleba grayish with a faint violaceous cast, near Wood Brown or Ecry Drab (o6) when ripe, white veins few, mostly springing from base, grey veins distinct.

Smell faint in young specimens, and then taste like nuts, ripe specimens often smelling aromatic, the taste more sharp.

Peridium 200–500 μ thick, external part pseudoparenchymatic, 3–4 outer cell layers with brown walls, few to several layers subhyaline, cells 6–10 μ broad intergrading into dense filamentous layer of hyaline, interwoven hyphae; towards the gleba in most specimens seen is a layer of subparallel hyphae, narrow and inconspicuous in some, broad and distinct in others; asci almost globose, with a distinct pedicel, at times with a clamp-like crozier at base, main body 60–70 μ diam., stipe 10–70 μ long, most asci 4-spored but 1–3 spored ones occur and 5-spored asci are rather common; spores comparatively pale and dull brown, elliptic,

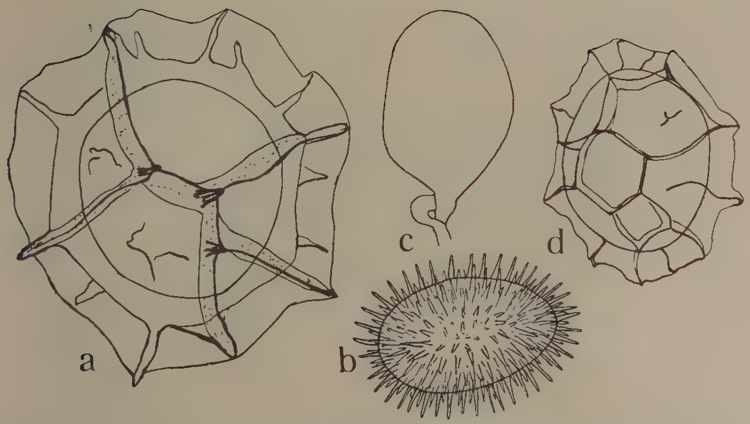

Fig. 9. *Tuber excavatum* subsp. *fulgens:* a Spore (×1100). *Tuber rufum*: b Spore (×1100); c Young ascus with "clamp connection" (×500). *Tuber aestivum* subsp. *uncinatum*: d Spore (×1100).

42–46 × 26–29 μ (1-spored) 23–30 × 19–22 μ (4-spored) including sculpture of spines 3–4 μ long.

Tuber rufum seems to be the most common species of the genus in Denmark; it is found in deciduous wood, often along paths, just below the soil surface, rarely partly exposed.

The variability in color and peridial characters is considerable and has provoked the erection of several taxonomic units. *Tuber ferrugineum* VITT. is the first of these; neither the description nor the authentic specimens I have seen (Uppsala Herb.) give possibilities of retaining this species as a distinct taxon. A smooth, bright colored, generally small form was called *T. nitidum* by VITTADINI and this species has been considered tenable by most later authors. I have no typical *T. nitidum* in my collections, but several specimens with yellow peridium and more or less distinct warts form transitions making it unlikely that *T. nitidum* could be retained as distinct. *T. scleroneuron* B. & BR. is another synonym and so is *T. rutilum* HESSE. FISCHER (1923) considered this latter taxon a subspecies of *T. rufum*, distinguished on the prominent inner peridial layer of subparallel hyphae, and such a layer is noted in several of my collections (ML4005, 4016, 4017, 4061, 4417) but the inner peridial layer varies so much in development that it cannot be used as distinction, and

its presence is not correlated with smooth peridium and pale spores as indicated by KNAPP (1950–52). American specimens of this group are generelly referred to *T. candidum* HARKN. Material from Michigan, U. S. A. (ML1618) is, however, hardly distinct from Danish specimens, and *T. candidum* is better considered a synonym of *T. rufum*.

Danish finds: Numerous collections from Fyn, Jylland, Lolland, and Sjælland. First reported by ROSTRUP (1884).

Tuber aestivum VITT. subsp. **uncinatum** (CHATIN) FISCHER 1897, p. 40.

Syn.: *T. uncinatum* CHATIN 1887.

Fig. 9, p. 39.

Fruit body 2–7 cm broad, globose or somewhat irregular-lobed; peridium blackish brown to black, made up of pyramidal, coarse warts, mostly with pentagonal base and furrows from base to ± pointed apex; gleba Wood Brown to Ecry Drab (o6–c4) with close network of white veins.

Smell nutty when young, pungent in very mature specimens, taste nutty. Warts about 700 μ high, outer 50 μ deep layer of dark brown, fused cells with thick walls or almost without lumen, here and there giving rise to long, flexuose, pale brown hairs, 3 μ broad; under this layer a largecelled pseudoparenchyma, of yellowish brown, ± radially arranged cells, 10–15 μ broad, central part of warts of interwoven, hyaline hyphae, inner peridium of subparallel hyphae, 3–4 μ broad, a few conspicuously broader, 6–7 μ; asci short elliptic, 85–95 $\times$ 55–60 μ to almost globose, diam. 60–80 μ, 1–6-spored, with distinct stipe; spores rather pale brown, broadly elliptic, 29–32 $\times$ 24–27 μ (4-spored), 38–40 $\times$ 30–32 μ (1-spored), including sculpture of 4 μ high reticulum, meshes rather broad, 6–12 μ, often with subsidiary ridges, tips of spines often curved.

Very rare in Denmark, but in one of the localities (Holbæk) occuring in abundance (BUCHWALD, 1954).

The specimens studied belong in *T. uncinatum* CHATIN, if this species is to be looked upon as sufficiently distinct from the typical *T. aestivum*, which is said to be characterized by larger warts and slightly different spores.

Danish finds: Herlufsholm, S., June 1903 (ROSENVINGE, 1906 (M.H.)); – ML4002, Marienlyst, Vordingborg, S., under *Quercus* on clayey-gravely soil, Sept. 5, 1951; – ML4069, Holbæk, S., Dec. 14, 1951 (cp. BUCHWALD, l. c.).

Tuber excavatum VITT. subsp. **fulgens** (QUEL.) FISCHER 1897, p. 57.

Syn.: *T. fulgens* QUEL. 1879.

Fig. 9, p. 39.

Fruit body 2–3 cm broad, globose, slightly lobed, surface rugulose-folded; basal cavity externely seen as a small hole but forming prominent cavity in section; peridium with small, low warts, deep orange brown; gleba dark ochre yellow (becoming purple black when old according to current descriptions), veins paler, radiating from cavity which is irregularly folded and similar to peridium.

The dried fruit body is bone hard, and can only be cut open when thoroughly moistened.

Warts on peridium about 200 μ high, of deep yellowish brown pseudoparenchyma with isodiametric-rounded and more oblong, thickwalled cells, 8–14 μ broad, similar tissue, a few cells deep, is seen between the warts; inner peridium 600–800 μ thick, of closely interwoven, thick-walled, subhyalin-brownish hyphae, similar tissue in veins, while hyphae in fertile gleba are paler and more thinwalled; asci oblong-clavate, about $130 \times 60\,\mu$, to subglobose, diam. 70–80 μ, with a distinct stipe, 5–35 μ long, mostly 3-spored but 1-, 2- and 4-spored asci not infrequent; spores almost globose, diam. in 3-spored asci 40–44 μ, in 1-spored asci 50–54 μ, including sculpture, a 6–8 μ high reticulum, thickwalled, meshes wide, 10–18 μ diam., often with subsidiary ridges.

The species is here described from dried material; it is only found once in Denmark, but reported as common in Central Europe.

Tuber excavatum is often split up in several taxa. The typical form is described as more dull colored and not distinctly warty, while the warty, rich-colored peridium of the present specimen refers it to *T. fulgens* QUEL. Whether or not *T. fulgens* deserves specific rank could not be evaluated on the available material.

Danish find: PAH7233, "North Zealand, garden under *Corylus*", fall 1935; collector and precise locality unknown; filed as *Melanogaster* sp.

Tuber scruposum HESSE 1894, p. 30.

Fig. 10, p. 42.

Fruit body about 1 cm broad, strongly lobed, hard; peridium covered by low, small but distinct warts, yellow (k5, Ochraceous Tawny to dull Ochraceous Orange); gleba white at first, then grayish vinaceous, rather

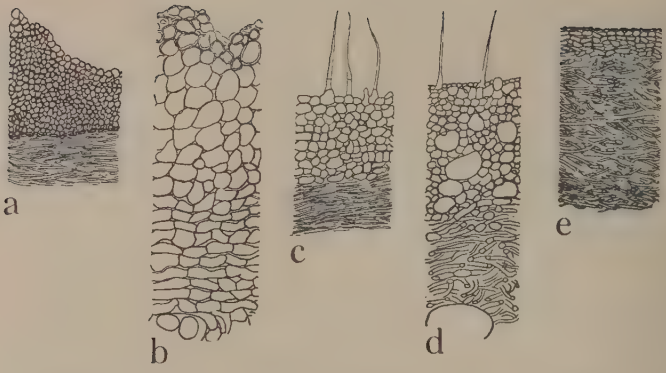

Fig. 10. Section of peridium of *Tuber scruposum* (a); *Tuber foetidum* (b); *Tuber puberulum* (c); *Tuber borchii* (d); *Tuber maculatum* (e) ($\times 100$).

dark when ripe; veins whitish to cream color, few but conspicuous, springing from all over the peridium.

Smell and taste faint.

Peridium 300 μ thick, incl. warts, about 100 μ high, outer part pseudoparenchymatic, of rounded cells, 8–12 μ broad, pale yellowish, inner layer 50–75 μ thick, of closely interwoven, subhyaline hyphae, 3–4 μ thick; asci subglobose, about 60 μ broad, shortly stipitate or sessile, mostly with 1–3 spores, but 4-spored asci occur; spores elliptic, the larger ones generally rather narrow, from 1-spored asci 47–57 $\times$ 30–34 μ, from 3-spored asci 32–36 $\times$ 21–24 μ, including sculpture, of narrow meshes 4–7 μ broad, (about 7 per length), 3 μ high.

Macroscopically the species recall a small *T. excavatum*, but the fruit body is solid, and the microscopical characters quite different. HESSES description covers the present plant well. *T. scruposum* seems to be a very rare plant, and it has only been found once during this investigation.

Danish find: ML4208, Ryget by Værløse, S., clayey soil along path, under spruce and beech, Aug. 22, 1952.

Tuber puberulum BERK. & BR. 1846, p. 81.

Fig. 10, p. 42.

Fruit body small, generally less than 1 cm broad, rarely up to 1.5 cm, soft and brittle, regular or $\pm$-distinctly lobed; peridium long remaining pale (Light Pinkish Cinnamon (h4) to almost white) darkening much when fully ripe, covered all over with fine, white puberulence, dis-

appearing only when fully mature; base with small, scurfy depression, similar, smaller holes or depressions scattered on peridium, most easily visible when dried; gleba pale (Pale Grayish Vinaceous, c7) turning dark liver brown when fully ripe (Maroon, Bone Brown (c1–2) or sometimes more rusty brown; veins rather few, white, mostly springing from base, large veins not entirely closed, with loosely woven tissue.

No taste or smell noticed.

Peridium thin, 100–200 μ, outer layer a subhyaline pseudoparenchyma, the cells 10–20 μ broad, densely coated with 100–150 μ long hairs, 5 μ broad at base, apex 1 μ, rarely with shorter and more blunt hairs; inner peridium a 30–60 μ thick layer of interwoven to subparallel hyphae, 3–5 μ broad; hyphae of gleba slightly broader, distinct from peridium; asci mostly 1–2-spored, almost sessile and subglobose, 80–100 μ broad; spores nearly globose 30×28 to $55 \times 50\,\mu$, including reticulum with narrow meshes, 3–8 μ broad, 4 μ high, fully ripe spores rich dark brown color.

Rather common, found both in deciduous wood and under conifers mixed with *Corylus*, but always on light sandy soil, often just under the leaves.

The species is well defined on its peridial characters and on the large globose, narrowly reticulate spores; all recent authors record it under this name and find it to be a common species. It is very closely related to the two following species.

Danish finds: ML4056, Firegårde, Ry, J., Oct. 16, 1951; – ML4058, Linå Vesterskov, J., Oct. 15, 1951, leg. M. Lange & Eckblad; – ML4064 Glenstruplund Skov by Assens, J., Oct. 28, 1951, leg. A. Klinge; – ML4160, Ugerhalne Plantage, J., Aug. 9, 1952, leg. A. Klinge; – ML4200, Rude Skov, S., Aug. 20, 1952; – ML4285, Varna by Århus, J., Oct. 10, 1952, leg. K. Bülow; – ML4416, Krogenberg Hegn, S., Sept. 6, 1953; – ML4424, ibid., Sept. 9, 1953; – ABK15, Glenstruplund Skov by Assens, J., Sept. 27, 1953.

Tuber rapaeodorum Tul. 1843, p. 380.

Fig. 10, p. 42.

Fruit body small, up to 1 cm broad, regular or lobed; peridium pale (Cinnamon Buff, g6–g7) with a $\pm$ distinct whitish bloom and scattered small scurfy, circular holes or depressions; gleba with well defined white veins springing from whole perifery, fertile part paler than peridium at first, dark brown (Maroon – Bistre, c3) when mature.

Taste none, odor faint, or more strong in mature specimens.

Peridium 200–300 μ thick, outer layer pseudoparenchymatic, cells 10–30 μ broad, pale yellowish, 3–4 outer cell layers slightly darker, set with 75–100 μ long, narrow, pointed hairs; inner layer of peridium 50–75 μ thick, of subhyaline 3–4 μ thick, subparallel hyphae, well set off from the gleba which is made up of slightly broader hyphae, loosely interwoven in broader parts of veins; asci globose to short elliptic, almost sessile, mostly 2–3-spored; spores elliptical, spherical ones rare to absent, pallid dull brown, 49–63 × 32–44 μ (1-spored), 40–43 × 30–33 μ (2-spored) as small as 26 × 21 μ in 3–4-spored asci, including reticulum, meshes small to medium, 4–8 per length, 3–8 μ broad, 3–5 μ high.

Probably rare. The three Danish collections were all made in beech wood on good soil, and the specimens were hypogean.

The name *Tuber rapaeodorum* has been used widely to cover any small *Tuber* with a fairly strong smell. The species is, however, quite well defined through TULASNE's very detailed figure of the structure of peridium, gleba and spores, and the same characters have been noted in an authentic specimen studied by me (Uppsala Herb.). A few hairs were noted in the specimen studied while the drawing shows no hairs. It is very closely related to *T. puberulum*, hardly distinguishable macroscopically, except possibly on the difference in the veins, microscopically on no other significant character than the paler, elliptic spores. There are some indications that the ecological requirements are different for the two species, *T. rapaeodorum* prefering much richer soil.

Danish finds: ML4015, Allindelille, S., Sept. 9, 1951; – ML4218, Dyrehaven, S., Aug. 22, 1952; – ABK11, Rugård Sønderskov, Djursland, J., Aug. 31, 1953.

Tuber borchii VITT. 1831, p. 44.

Fig. 10, p. 42.

Fruit body 1.5 cm broad, slightly lobed; peridium long remaining very pale whitish, covered by fine bloom, here and there with small, circular, scurfy holes; gleba becoming dark brown (c3, Maroon) when mature; veins distinct, relatively narrow and branched, some of them not entirely closed.

Smell and taste not noted.

Peridium 300–500 μ thick, very variable in same fruit body, outer layer 200–300 μ, pseudoparenchymatic, cells 10–50 μ broad single layer on surface of small yellow cells, giving rise to narrow, pointed hairs, 70–100 μ long; inner layer of interwoven hyphae, 5–9 μ broad, not well set off from gleba, made up of similar hyphae, here and there with looser tissue

of pseudoparenchymatic character in the broader veins; asci globose to subglobose, 70 μ broad to 65 × 75 μ, almost sessile, 1–2-spored, 3-spored rare, 4-spored not seen; spores elliptic, dull pale brown, 45–55 × 43–37 μ (1-spored), 40–43 × 30–32 μ (2-spored) including sculpture of rather large meshes, 4–6 per length, 6–10 μ broad, 3–5 μ high.

Probably rare in Denmark, only represented by one collection, a single, well developed specimen.

Whether or not this is the true *T. borchii* of VITTADINI is hard to say, as no type material has been seen, but it agrees well with the original description and figure. I have compared it with material referred to *T. borchii* by HAWKER (1954), and there is no doubt that it is the same species as described by her. *T. borchii* is very closely related to *T. puberulum* and *T. rapaeodorum*, differing from both mainly in the thick peridium with coarse hyphae in the inner layer, not separated from gleba, and from the former also on the elliptic, pale spores.

Danish find: ML4248, Århus, J., in beechwood, Sept. 4, 1952, leg. K. BÜLOW.

Tuber foetidum VITT. 1831, p. 41.

Fig. 10, p. 42.

Fruit body 0.5–1.3 cm broad, regular to somewhat lobed; peridium of young specimens Cinnamon Buff (g7), mottled with darker brown, soon dark brown all over, Cinnamon Brown or Sepia (g8), scrupose to obscurely warty from low, flat warts, in places with very inconspicuous felt on young specimens; gleba dark when ripe, Army Brown to Drab (j3, c3), with prominent, white veins springing from all sides of peridium; texture rather firm.

Taste like nuts with faintly bitter aftertaste, smell slight, rancid in some old specimens.

Peridium 300–450 μ thick (fresh), outer part pseudoparenchymatic, the 2–5 outer cell layers brown, more brown-colored cell layers in the warts where present; main layer a hyaline pseudoparenchyma, cells about 30 μ broad, towards gleba grading into a layer of inflated, 10–15 μ broad hyphae; gleba made up of hyphae about 8–10 μ thick; asci almost sessile, subglobose, 70–90 μ diam., 1–5-spored, 3-spored asci dominant in some specimens, 4-spored in others; spores rich brown, short elliptic to almost globose, 30–37 × 27–33 μ (4-spored) 45–50 × 41–44 μ (1-spored), reticulate, meshes wide, 3–5 per spore length, 6–18 μ broad, 4–5 μ high, sometimes with subsidiary ridges.

Not common, found in rich soil in deciduous wood.

The microscopical characters of the Danish specimens agree well with those of an authentic specimen from VITTADINI in Uppsala Herb. The species is well characterized through its external similarity to *T. rufum*, and almost all authors seem to have interpreted VITTADINI's species correctly, although the rancid smell is an inconstant character.

Danish finds: ML4209, Ryget, S., Aug. 22, 1952; – ML4231, Rude Skov, S., Aug. 25, 1952; – ML4239, ibid., Aug. 29, 1952; – ML4286, Frederikslund Skov, S., Oct. 1, 1952; – ML4591, Purreskov, Lundeborg, F., Aug. 8, 1954.

Tuber maculatum VITT. 1831, p. 45.

Fig. 10, p. 42.

Fruit body 0.8–2.5 cm broad, smaller specimens almost regular, larger ones somewhat lobed; peridium white to clay color (Cartridge Buff, Tilleul Buff to Cinnamon Buff, b8, g6–7, f8, h4), spotted with Light Ochraceous Salmon (e7) or similar, more brownish shades (pale Wood Brown), fresh specimens with a faint whitish bloom; gleba white, then watery grayish and finally Wood Brown to Army Brown (o6–j3) with distinct, branched white veins springing from all over peridium.

Tast nutty with slightly bitter aftertaste, smell faint.

Peridium 200–400 μ thick, outer layer of 3–6 rows of brownish cells, rectangular or more rounded, 7–10 μ broad, often in distinct rows, intergrading with main layer of interwoven (or in places subparallel) hyaline hyphae, 4–8 μ broad; asci stalked to sessile, subglobose, 1–4(5)-spored, 4-spored ones dominant in all specimens, and 1–3-spored asci sometimes almost absent; spores short ellipsoid, very variable, smallest spores in 4-spored asci 24–36 μ long, largest spores in 1–2-spored asci varying from 39–59 μ in different specimens, but mostly $32 \times 24\,\mu$ in 4-spored asci and $50 \times 34\,\mu$ in 1-spored asci, including reticulum of moderately large meshes, 4–8 per length, 4 μ high, 4–9 μ broad.

Common, in deciduous woods, hypogeous.

The present material has been compared with an authentic specimen from VITTADINI (Herb. Uppsala). It agreed very well with this specimen both in spore characters (4-spored) and peridium. It is, however, very likely that several taxa are covered by above description. They have, however, all the main characters of peridium, and 4-sporedness of the asci in common. FRIES (1909) distinguishes several varieties; the plant described here corresponds best to his var. *suecicum* (WITTR.). BUCHOLZ has dealt in detail with the group (1901), and the present form seems best covered by his *T. intermedium*. It is almost certain, that *T. dryophilum*

TUL. sensu HESSE is synonymous, and very likely does the same hold true for this species as concieved by MALENÇON (1938). It may also be that the plant described by TULASNE actually is this species, but FISCHER (1897) and HAWKER (1954) has interpreted *T. dryophilum* differently, ascribing spores with very large meshes to it. I have studied the type of *T. dryophilum* (Paris Herb.). It has spores with 2–5 rather regular meshes per length, recalling *T. foetidum*. The peridium revives very badiy and is attacked by parasites, but seems to be of the same type as in *T. rapae-odorum*. It will be very difficult to pass a final judgement on this material. The same sheet contains a specimen identified as *T. dryophilum* by BERKELEY and probably confirmed by TULASNE. It is a typical *T. maculatum*. The species referred to *T. dryophilum* by HAWKER is in all probability clearly distinct from the type, the peridium is different, and the spores have 1–2 very irregular meshes.

Danish finds: Numerous specimens from Sjælland, Fyn, and Jylland.

Tuber sp.

Fruit body large, 2–6 cm broad, somewhat flattened, irregularly folded-lobed, easily cut when dry; peridium pallid tan; gleba (ripe) Light Pinkish Cinnamon to pale Wood Brown (h4–o6), veins very numerous, narrow, anastomosing.

Smell strong, pungent.

Peridium 350–600 μ thick, outer part of 4–6 layers of brownish, thickwalled rectangular-rounded, 6–15 μ broad cells, intergrading with main layer of hyaline, interwoven, rather thickwalled, 4–6 μ broad hyphae; asci 1–4-spored, 3-spored ones dominant, 4-spored asci frequent; spores very variable, from rather narrowly elliptic to almost globose, mostly about $32 \times 25\,\mu$ (4-spored) and $50 \times 37\,\mu$ (1-spored), including reticulum of 4–5 μ high meshes, large in some spores (10–14 μ, 3 per length) rather small in others (6 μ broad, 6–7 per length).

This very large and conspicuous trufle was at first referred to *T. magnatum* PICO ex VITT. The macroscopic characters agree well with this species, but the microscopic features are quite different, as *T. magnatum* is characterized by almost globose spores with wide meshes, and 1–2-spored asci.

Danish find: ML4044, Lille Valby by Roskilde, S., several specimens in sandy soil under *Corylus* in garden, Sept. 24, 1941, leg. H. NIELSEN.

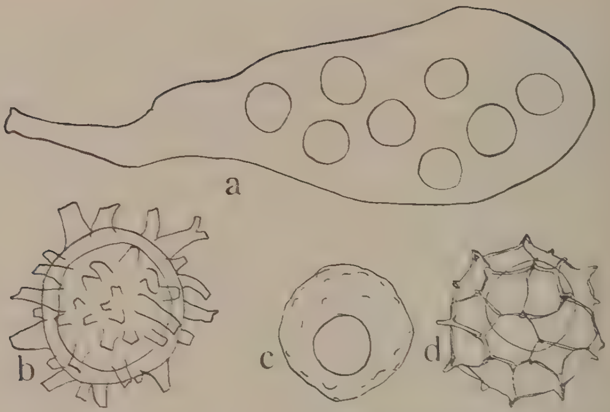

Fig. 11. *Choiromyces venosus*: a Ascus (×500); b Spore (×1100). *Hydnobolites cerebriformis*: c Unripe spore; d Ripe spore (×1100).

Terfeziaceae

The two Danish genera referred here, *Choiromyces* and *Hydnobolites*, are often included in the preceding family, but they seem to be without true venation in the gleba, and the peridium is more poorely organized than in *Tuberaceae*. The asci are globose-sackshaped, with 8 globose, sculptured spores. Some exotic species have smooth, elliptic spores.

Choiromyces Vittadini

The genus is only represented by one Danish species, our largest and most conspicuous hypogéa. Other European species mentioned in the literature are probably synonymous.

Choiromyces venosus (Fr.) Th. Fr. 1909, p. 240.

Syn.: *Mylitta venosa* Fr. 1830, *Choiromyces meandriformis* Vitt. 1831.

Fig. 11, p. 48.

Fruit body irregularly folded-lobed, up to 10 cm broad or more; peridium almost smooth, slightly fibrillose-scrupose sub lente, more so in the folds, pallid, Pinkish Buff (g6) or paler, in places spotted Vinaceous Buff to Fawn Color (j1–3), peridium thin; gleba solid with grayish buff, later brownish, labyrinthine parts.

Smell faint when fresh (like *Tuber rufum*), much stronger when decaying.

Peridium 400 μ thick, with an outer pseudoparenchymatic layer, appearing faintly brownish, main layer hyaline, of interwoven hyphae; sterile part of gleba of hyaline, loosely woven hyphae, 5 μ broad, a few up to 15 μ, fertile parts of similar hyphae more densely packed; asci sackshaped, often with a long stipe, sporiferous part 100–120 × 50–60 μ, stipe up to 120 μ long, 8 spores (rarely fewer) in two rows or irregular; spores globose 22–30 μ broad incl. spine-like processes, 3–6 μ high, 16–19 μ broad without sculpture, ripe spores pale brown.

Rare, and only reported from Jylland, 3 finds from around Vejlefjord and one record from Århus.

Danish finds: Vejlefjord, J., July 2, 1888, leg. J. E. LANGE (ROSTRUP 1889); – ibid., Oct. 1907, leg. O. HØRRING; – ibid. Sept. 27, 1953 (cp. S. HERTZ 1954); – Århus, J., Aug. 1915, leg. POUL LARSEN; – Kolding, J., Oct. 1931, leg. POUL LARSEN, det. C. A. JØRGENSEN.

Hydnobolites cerebriformis TUL. 1843, p. 379.

Fig. 11, p. 48.

Fruit body small, up to 1 cm across, but more often 0.4–0.5 cm, irregularly folded-lobed; peridium smooth, pale Cream Color (e5) then more brownish: Light Ochraceous Salmon to Ochraceous Tawny (g3–2); gleba concolorous, solid, but some folds reaching almost to centre and appearing like cavities in some sections, peridium not well defined, about 70–150 μ thick, of claviforme to globose, inflated endcells of glebal hyphae, 10–20 μ broad, almost hyaline, in some places sparingly covered with protruding, hairlike hyphae; gleba of interwoven hyaline hyphae, 5–8 μ broad, some elements ± inflated; asci evenly distributed all over ripe gleba, almost globose, 100 × 80 μ, with a stipe about 25 μ long; 8 spores irregularly arranged, sculptured by very open reticulum, 21–25 μ broad including sculpture, 2–4 μ high. No distinct reaction with Iodine, the peridium staining faintly brownish.

Only known from two Danish localities, on slopes with clayey soil in copses, under *Corylus*.

The present material differs from *H. cerebriformis* as currently described, in the very scanty occurrence of hairs on the peridium. *H. fallax* HESSE and *H. tulasnei* HESSE (non BERK. & BR.) are probably synonyms.

Danish finds: ML4050–53, Firegårde Skov, Ry, J., Oct. 16, 1951, leg. M. P. CHRISTIANSEN, M. LANGE, & V. PEDERSEN; – ABK 59, Ajstrup v. Hadsund, J., Oct. 10, 1954, leg. A. KLINGE.

Basidiomycetes

The hypogeous basidiomycetes form a very heterogeneous group. Some genera are obviously related to genera of *Agaricales*. It is thus generally agreed that *Arcangeliella* is related to *Russulaceae*, connected through stipitate forms as *Macowanites*, and *Rhizopogon* seems to have similar relations to *Boletaceae* through *Truncocolumella*. It may be possible to place *Hymenogaster* in some relationship to *Cortinariaceae* through *Thaxterogaster*, which at least on its side is close to *Cortinarius* while the hiatus towards *Hymenogaster* is less easily bridged. No similar suggestions can be made concerning the relations of *Hysterangium* (and *Gautieria*) which differ in mode of development, forming hymenium over a complexly folded columella. It is a highly controversial issue whether the genera related to agarics are primitive or reduced. The present author prefers the latter hypothesis but the epigeous *Gasteromycetes* mentioned above as connecting links, do not occur in Denmark, and are not sufficiently well known to me to invite new support for either theory to be set forward here.

The basidiomycetaceous hypogeas share ecological characters with the true truffles, and are frequently found together with species of *Tuberales*. They are easily distinguished from the *Ascomycetes* on the structure of the gleba, made up of rather regular, often open chambers. Very mature specimens are identified as *Basidiomycetes* when noting the small remnant of the sterigma at base of the spore.

Key
to the genera of hypogeous *Basidiomycetes*

1. Spores globose.................................... 2
1. Spores elliptic-elongate or ovate, smooth, rugulose or warty ....
2. Spores echinate-spiny............................. 3
2. Spores echinate-warty or subreticulate, thickwalled ... 4
3. Gleba with lactifers .... *Arcangeliella* p. 51
3. Gleba without lactifers............................ (*Hydnangium* p. 51)
4. Gleba chambers very small, spores thickwalled, warty. (*Sclerogaster* p. 53)
4. Gleba chambers filled with hyphal tissue, spores with gelatinous coating................................. (*Leucogaster* p. 53)

5. Spores dark brown, smooth, gleba chambers filled with hyphal tissue .... *Melanogaster* p. 58
5. Gleba pallid, brown or greenish, spores subhyaline to brown 6
6. Spores smooth, subhyaline 7
6. Spores rough, carinate or with distinct gelatinous sheath 8
7. Peridium pallid tan to reddish with coarse fibrils, spores < 12 μ .... *Rhizopogon* p. 53
7. Peridium whitish, with basal rhizomorphs or naked, gleba greenish, spores > 12 μ .... *Hysterangium* p. 76
8. Peridium almost absent, gleba cartilaginous, spores carinate.. (*Gautieria* p. 75)
8. Peridium distinct, gleba soft 9
9. Peridium white, turning blue, spores carinate .... (*Chamonixia* p. 75)
9. Peridium white or brownish, spores warty, rugulose or smooth.. *Hymenogaster* p. 65

Hydnangiaceae

Spores spherical, rarely broadly ellipsoid, verrucose to echinate-spiny, the spines amyloid or pseudoamyloid. Sphaerocysts and lactifers sometimes present in the tissues.

Hydnangium WALLROTH

Peridium thin, spores rather thinwalled, echinulate, gleba chambers gyrose, empty at maturity, no distinct lactifers present. *Hydnangium carneum* WALLR. is recorded from Sweden (cp. FRIES, 1921).

Arcangeliella CAVARA

The echinate-spiny spores and the presence of lactiferous hyphae show, among other characters, the relationship of this genus to *Russulaceae*, thus far removed from apparently similar forms of *Hymenogasteraceae* and *Rhizopogonaceae*, while closely related to *Hydnangium*. It is not unlikely that further studies might prove it desirable to unite *Hydnangium* and *Arcangeliella* in one genus. The nomenclatorial status of the name *Arcangeliella* is much discussed. *Octaviania* VITT. could hardly by typified by a species not currently referred to *Melanogaster*, and also the status of *Octavianina* KUNTZE and *Arcangeliella* is dubious. The name *Arcangeliella* seems preferred at present, but the final decision should be left with somebody more involved than a Danish monographer, dealing with one species only.

Arcangeliella asterosperma (VITT.) ZELLER & DODGE 1935, p. 366.

Syn.: *Octaviania asterosperma* VITT. 1831.

Fig. 12, p. 53.

Fruit body 1–3 cm broad, rounded or somewhat lobed, generally ± distinctly flattened; peridium whitish, with appressed silky fibrils, in places with greenish sheen, dirty brown to almost black when touched (reddening in one specimen), separable, though not readily so; base with a few white rhizomorphs; gleba white at first, then brownish (g2. Ochraceous Tawny, or more dull), moist when cut but no real latex noted; chambers 0.2–0.4 mm broad, almost isodiametric, groups of 2–6 separated by slightly thicker septa; septa almost white, chambers empty when young, in older specimens almost filled with spores; small, white, sterile portion at base.

Smell sweetish aromatic.

Peridium 100–200 μ thick, of subparallel hyphae, 4–8 μ broad, the outer ones with dark dirty brown content when revived; septa 40–70 μ broad, hyphae subparallel; subhymenium distinctly cellular, scattered lactifers yellowish, 6 μ broad; basidia inflated clavate, 22–30 × 10–13 μ, 2 and 4-spored, sterigmata 5–8 μ long; no cystidia seen; clamp connections absent; spores strongly echinate-spinose, almost globose, 13.2–16.4 μ broad, including 3–4 μ high spines, brown, the color somewhat variable, 10–50 per cent. of spores distinctly pseudoamyloid, dark vinaceous in MELZER solution, young spores ovate.

Hypogeous or partly exposed, mostly solitary, large number of closely nested specimens in one coll. only, all but one specimen from rich clayey mull under beech.

ML4461 differs slightly from the other specimens, as the peridium stains vinaceous when bruised. It may belong in *Octaviania lutea* HESSE, but species related to *A. asterosperma* are badly known and not too well distinguished.

Danish finds: Munkebjerg by Vejle, J., 1888, leg. HJ. JENSEN (ROSENVINGE det.); – ML4000, Purreskov, Lundeborg, F., Aug. 28, 1951; – ML4031, Vallø Dyrehave, S., Sept. 9, 1951; – ML4032, Pramskov, Vallø, S., Sept. 9, 1951; – ML4033, Frederikslund Skov, S., Sept. 15, 1951; – ML4199, Rude Skov, S., Aug. 20, 1952; – ML4461, Ørnereden by Århus, J., Sept. 25, 1953, leg. K. BÜLOW; – ML4601, Dyrehaven, S., Oct. 3, 1955. A collection from Møen (M.H. and PAH (ROSTRUP 1895)) belongs in *Scleroderma bovista.*

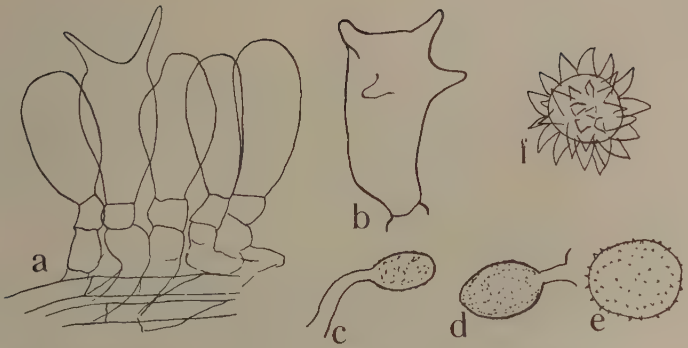

Fig. 12. *Arcangeliella asterosperma*: a Part of hymenium; b Basidium; c–e Unripe spores; f Ripe spore (all ×1100).

Sclerogaster Hesse

Fruit bodies small and hard, with minute chambers, early stuffed with spores, spores small, minutely warty, thickwalled, basidia 3–8-spored.

Rhizopogonaceae

Peridium rather thick, with adpressed rhizomorphs, gleba chambered, the chambers lined by hymenium or filled by tissue with basidia irregularly arranged. Spores smooth and elliptic-oblong in Danish genera; basidia 4–8-spored; glebal tissue deliquescing at maturity.

The genus **Leucogaster**, which probably belongs here, has globose spores, reticulate-pitted with a thick gelatinous sheath.

Rhizopogon Fries

Peridium pale tan, or whitish and turning red when bruised, gleba chambered, diffluent at maturity. Spores elliptic-cylindrical, subhyaline; basidia and paraphyses often gelatinous at maturity. All Danish species grow under pine, in sandy soil.

Key

1. Chambers stuffed with spores at maturity, peridium not turning red .... *R. luteolus* p. 54
1. Chambers remaining open, gleba red where bruised... 2
2. Paraphyses gelatinous-thickwalled, spores 7–9 μ long.. *R. rubescens* p. 55
2. Paraphyses thinwalled 3
3. Spores small 5–7 × 2–3 μ .... *R. vulgaris* p. 56
3. Spores larger .... (*R. roseolus* p. 56)

Rhizopogon luteolus Fr. 1817, p. 5.

Fig. 13, p. 55.

Fruit body up to 6–8 cm broad, subglobose or oblong, larger specimens sometimes lobed; peridium dark tawny olive, not turning red when bruised, but darkening somewhat; covered with a dense weft of fine, concolorous or slightly darker fibrills, forming several rootlets below; gleba olivaceous, the chambers stuffed with spores, deliquescing.

Odor foetid when mature.

Peridium 300–400 μ thick, outer layer about 25 μ, brown, of collapsing hyphae, main layer of interwoven, yellowish hyaline hyphae, 4 μ thick, not gelatinized, without clamp connections; septa hyaline, 50 μ broad of interwoven, somewhat gelatinized hyphae, 4 μ broad; paraphyses about 15 × 7–9 μ, thickwalled, wall probably gelatinized; basidia mostly 8-spored, 20–30 μ long, protruding over hymenium; spores 5.1–8.4 × 2.9–3.5 μ, averages 6.6–7.3 × 2.9–3.2 μ, elliptic-cylindrical, often irregular, with small remnant of sterigma at base, pale yellowish, dark yellowish brown in mass.

In pine wood on sandy soil, often in drift sand in plantations, hypogeal or partly exposed.

Anyone, who feels confident of the identity of *R. virens* (A. & S.) Fr., can follow Schroeter (1908), and on the sacred rules of priority substitute this name for *R. luteolus*. *Hysteriomyces graveolens* Vitt. is probably a later synonym. I have studied a small fragment of this species sent from Vittadini to Berkely and from him to Tulasne, and found it to share spore characters with *R. luteolus*. The original description suggests a small specimen of this species.

R. luteolus differs from the other Scandinavian species in lack of reddish pigments in the peridium, darker colors, and the stuffed gleba chambers. *R. briardi* Boud. is apparently closely related but the spores are broader and the peridium somewhat thicker.

Danish finds: PAH11, Bøtø Plantage, Falster, Oct. 1927, leg. F. H. Møller (cp. Møller 1927); – PAH195, Bordrup Plantage, J., Sept. 3, 1929, leg. N. F. Buchwald (cp. Buchwald 1930); – Råbjærg Mile, J., June 27, 1937, leg. C. A. Jørgensen (M.H.); – ML3397–3400, ibid., Oct. 5, 1950; – PAH7600, Fanø, J., Sept. 18, 1942, leg. K. T. Erstad; – PAH, Skagen Klitplantage, J., Sept. 6, 1946, leg. N. F. Buchwald; – PAH556, Sjelborg by Herning, J., Oct. 16, 1948, leg. O. Harder.

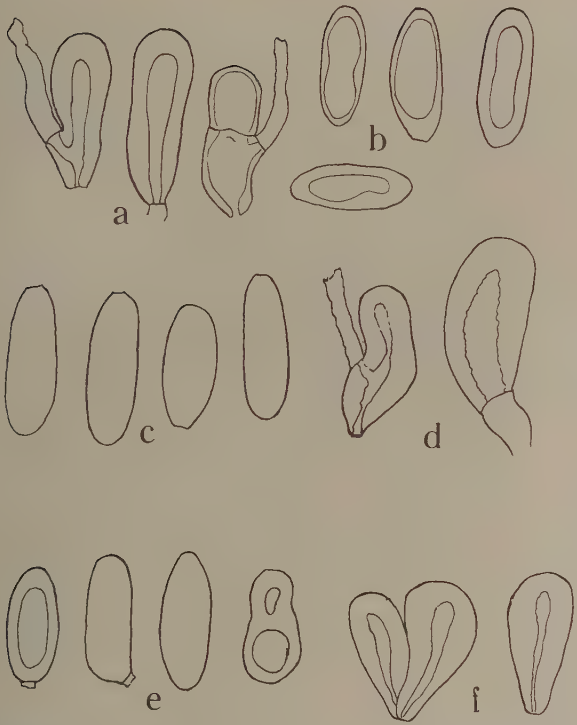

Fig. 13. *Rhizopogon rubescens*: a, d Paraphyses (×1100); b, c Spores (×2400); a, b ML1903; c, d coll. from Hyers, leg. TULASNE. *Rhizopogon luteolus:* e Spores (×2400); f Paraphyses (×1100).

Rhizopogon rubescens TUL. 1844, p. 58.

Fig. 13, p. 55.

Fruit body 1–3 cm broad, globose ovate; peridium olive tan, paler when young, turning dirty reddish when bruised; almost glabrous, with a few scattered rhizomorphs, forming one (rarely more) rootlet at base; gleba pale olive, darker olive when mature, dark brownish olive when deliquescing, chambers empty or nearly so.

Odor foetid when ripe.

Peridium 100–300 μ thick, outer layer pale and of rather loose texture,

hyphae 4 μ broad, inner layer more compact, with numerous red-brown pigment balls; septa 40–60 μ broad, hypha ± gelatinized; paraphyses 10–25 × 5–12 μ (outer segments measured, branched at base), thickwalled (wall probably gelatinized), basidia collapsing early, protruding; spores 6.7–9.5 × 2.6–3.2 μ, average 7.5–8.8 × 2.8–3.0 μ, elliptic-subcylindric with small basal scar.

Found in wood of *Pinus*, on sandy soil, partly or entirely covered.

Smaller size, darker color of peridium and gleba, somewhat larger spores, and thickwalled paraphyses, distinguish the species from *R. vulgaris*. The type itself seems lost, but a later specimen collected by TULASNE is preserved in Paris Herb. (Hyers, Jan. 1848, leg. TULASNE). It corresponds exactly to the drawing in TULASNE (1851) and may well be considered the type. The spores are slightly larger than in most other specimens, I have seen (average 8.8 × 3.0 μ) but all other microscopical characters are identical.

R. roseolus (CORDA) HOLLÓS may be an earlier synonym to *R. rubescens*. The original picture (STURM, Flora 3:3–4, pl. 2) seems to represent a larger species, and the description edited by ZOBEL (1854) together with CORDA's drawings, leaves little possibility for a definite interpretation. Tradition tends, however, to establish *R. roseolus* as a large-spored species, spores about 8–10.5 × 3.5–4.5 μ (or even 8–12 × 3–5.5 after ZELLER & DODGE, 1918). I have found this species in North Sweden (LANGE & HAWKER, 1952). It differs from *R. rubescens* not only in spore size, but also in larger, thinwalled paraphyses. It should be further studied. It is possible, that the problem can be solved, if CORDA's specimen still is found in Praha.

Danish finds: ML1903, 1966, 1966a, Tisvilde Hegn, S., Oct. 1947.

Rhizopogon vulgaris (VITT.) M. LANGE comb. nov.

Syn.: *Hysteriomyces vulgaris* VITT. Not. nat. civ. Lombardia 1: 341, 1844; *Rhizopogon provincialis* TUL. 1851; *R. rubescens* var. *vittadinii* TUL. 1851; *R. vittadinii* (TUL.) ZELLER 1939.

Fig. 14, p. 57.

Fruit body up to 4 cm broad, globose ovate, slightly flattened, larger specimens somewhat lobed; peridium cream color when young, then yellowish tan with slight olivaceous flush (exposed parts darker brown), turning pink where bruised; surface minutely felty fibrillose, often cracked, rhizomorphs inconspicuous and few on upper side, forming 1–3

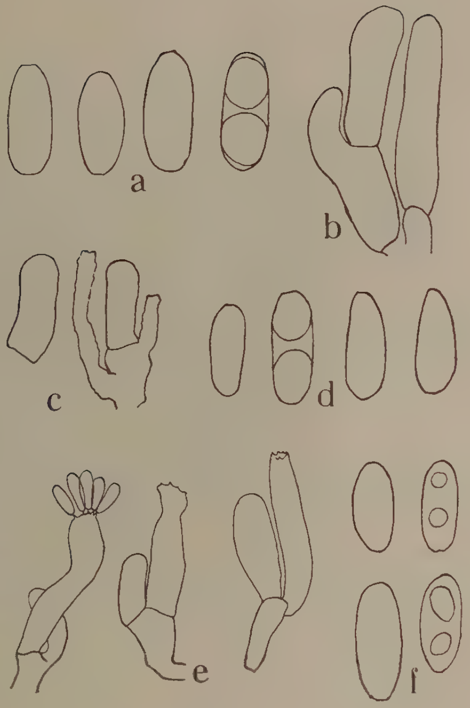

Fig. 14. *Rhizopogon vulgaris*: a, d, f, Spores (×2400); b, c, e, Paraphyses and basidia (×1100). a, b leg. TULASNE (type of *R. provincialis*); c, d leg. VITTADINI (type of *H. vulgaris* VITT. and of *R. rubescens* var. *vittadinii* TUL.); e, f ML1962.

rootlets below, brownish; peridium in section turning pink throughout; gleba pallid almost till maturity, chambers empty, mature gleba deliquescing.

Odor faint, like *Scleroderma*, strong and offensive in some mature specimens.

Peridium 300–600 μ thick, outer part with numerous, deep red pigment balls, inner part hyaline, hyphae 4–6 μ thick; septa 40–75 μ thick, of hyaline hyphae, hardly gelatinized, sometimes scizile; paraphyses thin-walled, hardly gelatinized, forming palisade, 4–7 μ broad, 12–26 μ long; basidia collapsing early and badly reviving, 4–8-spored, protruding over hymenium at maturity, mostly about $16 \times 4\ \mu$, sterigmata 1 μ long; spores in mass pale yellow, single spores almost hyaline, ellipsoid-cylindrical with small basal scar, often biguttulate, $5.3–7.4 \times 2.0–3.0\ \mu$, averages $5.6–6.8 \times 2.2–2.8\ \mu$.

Found in wood of *Picea* on old sanddunes, the fruit bodies most often

partly exposed and several growing together (M. LANGE, 1949, as *R. roseolus* (CORDA)).

The species is most readily distinguished on the small, narrow spores and the narrow, thinwalled paraphyses. To solve its nomenclatorial problems it has been necessary to study the material TULASNE worked on when describing the two above mentioned taxa. *R. rubescens* var. *vittadinii* TUL. is based on a specimen sent from VITTADINI to TULASNE, while *R. provincialis* TUL. is described from specimens from Hyers. Both types are kept in the Paris Herb. It is clear already from the original descriptions, that var. *vittadinii* differs from *R. rubescens* in the same characters by which *R. provincialis* is singled out, viz. small spores, thick peridium, and larger size. The only remaining character to separate var. *vittadinii* from *R. provincialis* is the numerous fibrils ascribed to the latter. No great weight could be ascribed to this, as the specimen in question of var. *vittadinii* was epigean, and thus should normally be more naked than a form covered by soil or litter. A comparison of the two specimens leaves in fact no possibility for keeping them apart, they are identical in all microscopical features, except that the spores of *R. provincialis* are slightly larger than those of var. *vittadinii* ($6.2–7.4 \times 2.6–3.0\,\mu$ and $6.0–7.1 \times 2.2–2.5\,\mu$ respectively). The fibrils ascribed to *R. provincialis* could no longer be traced.

Hysteriomyces vulgaris, Mediolani 1825, VITTADINI, should be considered the type of *R. vulgaris*, as well as of the later synonym *R. rubescens* var. *vittadinii*. The specimen is kept in Paris Herb. but an identical specimen is presumably in Rome, a fragment of this in Herb. Torino has been studied by me.

ZELLER (1939) has erected var. *vittadinii* to specific rank. His description of American material indicates that he has worked with another species, with gelatinizing paraphyses, but formally his species is based on *R. rubescens* var. *vittadinii* TUL. and a new name must be coined, if further studies show it to be different enough from other taxa.

Danish finds: PAH, Råbjerg Mile, J., Sept. 1946, leg. N. F. BUCHWALD; – ML1902, 1962, 1965, 2541, Tisvilde Hegn, S., Oct. 1947–1948.

Melanogaster CORDA

Peridium brown with adpressed brown rhizomorphs; gleba solid, chamber walls seen as pallid reticulum, deliquescing at maturity; spores subcylindric to broadly ovate, brown to dark brown.

Key

1. Spores rarely > 12 μ long 2
1. Spores larger 5
2. Spores dark brown 3
2. Spores pallid brownish, very small or narrow and slender 4
3. Spores subcylindrical, 7–9 × 4 μ .... *M. broomeianus* p. 59
3. Spores broadly ovate, 7.5–10 × 5.5–8 μ .... (*M. variegatus* p. 61)
4. Spores less than 6 μ long, fruit body small........... (*M. microsporus* p. 61)
4. Spores about 10 μ long, irregular cylindrical, very pale. (*M. rubescens* p. 61)
5. Spores 10–14 × 6–7 μ, peridium rich brown, large species.. *M. tuberiformis* p. 64
5. Spores larger, 13–20 × 8–10 μ 6
6. Fruit body rich brown, rather large................. *M. macrosporus* p. 62
6. Fruit body dull brownish olive, small............... *M. ambiguus* p. 61

Melanogaster broomeianus BERK. in TUL. 1843, p. 377.

Syn.: *Octaviania variegata* VITT. 1831 (pro parte), *M. variegatus* var. *broomeianus* (BERK.) TUL. 1851.

Fig. 15, p. 60.

Fruit body 1–4 cm broad, somewhat lobed, more rarely almost globose, often slightly flattened; peridium deep brown, surface minutely felty, sparingly covered with dark rhizomorphs; gleba becoming almost black, with white to pale yellowish septa.

Odor sweetish aromatic.

Peridium 300–400 μ thick with more or less prominent outer layer of 4–10 μ broad, yellow hyphae with clamp connections, in some specimens also dark brown hyphae in outer layer; central layer of brown hyphae, inner layer of compactly woven yellowish hyphae; septa about 50 μ broad, of hyalin or faintly yellowish, interwoven, gelatinizing hyphae; spores 7.2–9.9 × 3.4–4.9 μ, averages 7.8–9.0 × 3.7–4.3 μ, ovate to almost cylindric, broadly truncate below with broad remnant of sterigma, black in mass, individual spores chocolate brown.

The largest and most common species of *Melanogaster* in Denmark, mostly found in graveley soil under deciduous trees, often partly exposed, a large number of specimens nested together. June to September.

The nomenclature of this species is quite difficult and entangled. I have studied the authentic material of VITTADINI's *Octaviania variegata* in the Herb. Torino and found it to represent two species, with spores 7.5–10 × 5.5–8 μ and 7.2–9 × 3.8–4.1 μ respectively. Other authentic specimens are, according to ZELLER and DODGE (1937), to be found in

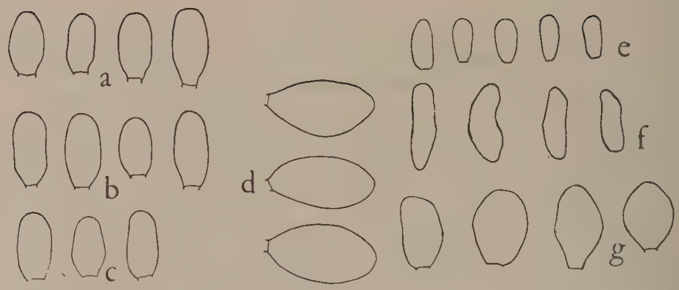

Fig. 15. *Melanogaster broomeianus*: a–c Spores (×1100); a ML3371; b ML4001; c PAH7145. *Melanogaster tuberiformis*: d Spores (×1100). *Melanogaster microsporus:* e Spores. (×1100) *Melanogaster rubescens:* f Spores (×1100), authentic specimen, Herb. Torino. *Melanogaster variegatus* VITT. s. str.: g Spores (×1100), authentic specimen, Herb. Torino.

various herbaria, and these authors, who had studied several of these, ascribe spores 7.5–10×5–7.5 μ to the type, not commenting on any other measures. This is later disregarded by SOEHNER and KNAPP, who base a new species, *M. vittadinii* on the broad spored form, and try to distinguish their *M. variegatus* from *M. broomeianus* on subtle differences in spore size (cp. KNAPP, 1954). Almost all authors dealing with *M. variegatus* have used the name for a species with narrow spores, but I see no possibility at present for questioning the typification proposed by ZELLER and DODGE. The name *M. broomeianus* should be used for the species most common in Northern Europe, and *M. variegatus* be reserved for a broad spored species, not frequently reported on. Under no circumstances could SOEHNER and KNAPP be followed, as the other authentic VITTADINI specimen shares spore characters with *M. broomeianus* as described by KNAPP (l. c.). If the taxon corresponding to *M. variegatus* sensu SOEHNER and KNAPP should be given any independent status, it must be given a new name.

One specimen (ML4218) is macroscopically quite different from the bulk of the Danish material. The peridium is vivid yellow, the fruit body very much lobed and shrinks considerably on drying. It may very well be *M. odoratissimus* (VITT.) TUL., which species, however, should have a reddish gleba before maturing, not noted in the present find. I have seen no authentic material of *M. odoratissimus.* A specimen in the Torino Herb. (coll. MATTIROLO) belongs in the *M. ambiguus* group.

Danish finds: About 20 collections from Sjælland, Fyn, Lolland and Jylland (cp. ROSTRUP 1888, 1905; FERDINANDSEN 1932; FAUERSCHOU 1949, 1950; M. LANGE 1950; CHRISTIANSEN 1954; WENG 1954; all sub *M. variegatus*).

Melanogaster variegatus (VITT.) TUL. emend. ZELLER & DODGE 1937, p. 651.
Fig. 15, p. 60.

The species reported on from Denmark under the name *M. variegatus* is here called *M. broomeianus*. *M. variegatus* s. str. with broad spores has as yet been found in South and Central Europe only.

Melanogaster rubescens (VITT.) TUL. 1851, p. 56.
Fig. 15. p. 60.

The interpretation of this species has caused great confusion, as TULASNE (1851) gives spore measures indicating very broad spores, and depict narrow ones. The original species described by VITTADINI (1831) has very slender, narrow spores. TULASNE drew his main description from material received from VITTADINI and still preserved in the Paris Herb. I have found it to be made up of three specimens, one of which has slender spores as depicted by TULASNE (l. c. Tab. XII), while the other two have broad spores and are very close to *M. variegatus* s. str. Another authentic specimen from VITTADINI has been studied in the Uppsala Herb. It has slender spores. TULASNE has apparently made a mistake, and *M. rubescens* is outstandingly characterized by narrow, rather pale spores, 9–10.5 × 3.5–4 μ. It is not recorded from Northern Europe. *M. rubescens* sensu ZELLER & DODGE (1937) is broad-spored and clearly must be something else.

Melanogaster microsporus VEL. 1922.
Fig. 15, p. 60.

Very small, the specimens seen not more than 3 mm broad. Well characterized by small, pale brown spores, 4–6 × 2.5 μ. Found in Norway by ECKBLAD, but not known from Denmark.

Melanogaster ambiguus (VITT.) TUL. 1843, p. 378.
Syn.: *Octaviania ambigua* VITT. 1831.
Fig. 16, p. 62.

Fruit body 1–2.5 cm broad, irregularly lobed, sometimes deeply constricted, as made up of two parts; peridium dull brown (g8, dark Cinnamon

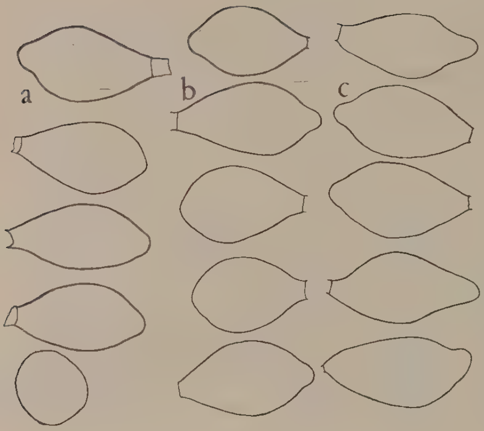

Fig. 16. *Melanogaster ambiguus:* Spores (×1100) a ML4250, one spore seen from top; b ML4191; c ML3310.

Brown) paler on drying (h2, dull Tawny Olive), smooth, with very low felt, ± wrinkled when dry; fibrils few, at the base; gleba black when ripe, with almost white septa; peridium dark in section, inner part whitish.

Smell like *Scleroderma.*

Peridium thick, 400–700 μ, surface with few, hyalin to brown, loose hyphae, 6–8 μ broad, with clamp connections; outer layer brown, of closely woven hyphae, 6–8 μ broad, the hyphae becoming paler and more narrow and compact inwards; septa 100–150 μ broad, of hyaline, closely woven hyphae, gelatinized around the chambers; basidia 4-spored; spores dark brown, 13.8–20 × 8.0–10 μ, averages 15.4–17.6 × 8.9–9 μ, some of them distinctly papillate-citriform, others with rounded apex, bases with distinct remnant of sterigma, rarely cupshaped.

In gravely-sandy soil under deciduous trees, probably rather common, single or a few specimens together.

M. ambiguus is distinguished from other large-spored species through its small size and the dull olivaceous color of the peridium. The papillate spores are not constant enough in occurrence to be regarded as a stable character. I have not been able to locate the type in the collections of VITTADINI in Torino nor in other herbaria.

Danish finds: Rude Skov, S., Aug. 2, 1903, leg. E. BRUSENDORFF; – PAH, Kjellerup, J., Oct. 1940, leg. O. LEGIND HANSEN; – ML3310, Frederikslund Skov, S., Aug. 4, 1950; – ML4191, Rude Skov, S., Aug. 18, 1952; – ML4250, Riis Skov, Århus, J., Sept. 10, 1952, leg. K. BÜLOW; – ABK1, Ajstrup Krat by Hadsund, J., May 31, 1953; – ABK28, Lundbjerg Krat by Randers, J., July 18, 1954.

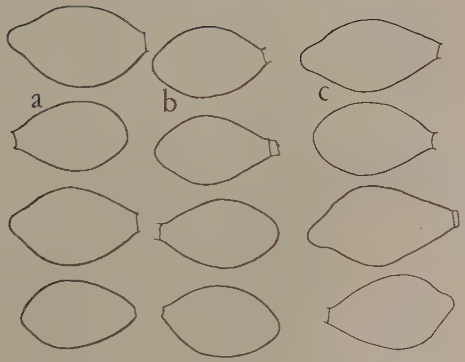

Fig. 17. *Melanogaster macrosporus*: Spores (×1100) a ML4057; b ML4237; c ML4445.

Melanogaster macrosporus VEL. 1922, p. 808.

Syn.: *M. ambiguus* var. *intermedius* BERK. 1844, *M. intermedius* (BERK.) ZELLER & DODGE 1937.

Fig. 17, p. 63.

Fruit body 1.5–3.5 cm broad, often somewhat irregular and ± distinctly flattened; peridium of a rich dark brown color (near cl Maroon-Bay), minutely felty, fibrils few, innate, rather coarse; gleba dark, color of septa not noted in fresh specimen, pale olive when dry.

Smell sweetish-pungent (noted in 4146 only).

Peridium 300–500 μ thick, surface with conspicuous, brown hyphae with clamp connections; outer layer dark brown, of compactly woven hyphae, 6–10 μ broad; inner part paler brown, more closely woven, of 2–3 μ broad hyphae; septa (distinct in 4237 only) about 40 μ broad, tissue around chambers distinctly gelatinized; basidia 4-spored; spores dark brown, 13.5–19.7 × 8.0–10.3 μ, averages 14.8–17.2 × 8.6–9.5 μ, apex rounded, rarely papillate (in 4445 many papillate), basis with remnant of sterigma.

Single or few specimens together in coniferous or more often deciduous wood, probably not common.

The best character distinguishing this species from *M. ambiguus* is the rich dark brown color of the peridium, (which makes the species look like *M. variegatus*, as noted by VELENOVSKY). Other differences seem to be larger size, narrow septa and peridium, and sweetish odor.

Melanogaster intermedius (BERK.) Z. & D. is evidently synonymous; both MASSEE (1889) and HAWKER (1954) found the type to have spores

as large as *M. ambiguus*, while ZELLER & DODGE (l. c.) gives smaller spores, which makes a study of their American material necessary.

Danish finds: ML4057, Firegårde Skov, Ry, J., Oct. 16, 1951, leg. F.-E. ECKBLAD; – ML4237, Østrup Skov, Randers, J., Aug. 24, 1952, leg. A. KLINGE; – ML4146, Mols Hoved, J., July 27, 1952, leg. A. KLINGE; – ML4445, Stenrand Plantage, Svebølle, S., Oct. 10, 1953, leg. M. P. CHRISTIANSEN & M. LANGE. Two older collections should probably be referred here: PAH7352, Fænø, Aug. 1889, leg. ROSTRUP (ROSTRUP 1892); PAH7312, Møens Klinteskov, Aug. 1901, leg. ROSTRUP (ROSTRUP 1905).

Melanogaster tuberiformis CORDA 1831, Fig. 1.

Fig. 15, p. 60.

Fruit body about 4 cm broad, almost globose, slightly flattened; peridium of a warm brown color (j4, Kaiser Brown – Garnet Brown), appressed-felty, upper surface somewhat cracked; rhizomorphs few, rather coarse (0.8 mm broad), adnate-ingrown or free, springing from 3-4 places on lower half of peridium, concolorous, darker when touched; gleba chambers rather variable in size; septa yellowish (k4, Cream Buff), fertile part black, gelatinizing.

Smell like *Scleroderma*.

Peridium 500–600 μ thick, outer layer 50 μ thick, of thickwalled, 6-9 μ broad, loosely woven, red-brown hyphae with clamp connections; main layer of densely woven, pale brown hyphae, 5–6 μ broad, or more narrow in inner part where they are more or less gelatinized; septa 80–200 μ broad, hypha gelatinized, except for a few oleiferous ones with citron yellow content; basidia born on hyaline, 2–4 μ broad hyphae with clamps, $40–50 \times 8–13\,\mu$, with 4–8 spores (rarely 3 or 9); spores dark brown, $10.5–14.4 \times 5.8–6.8\,\mu$, average $11.9–12.0 \times 6.3–6.4\,\mu$, elliptic ovate, broadest on or above middle, narrow below, with a short stipe.

The two records which give details of habitat, reports the specimens found in small number (1–3), in beech wood on acid soil, partly exposed. The species is presumably rare in Denmark, large and conspicuous, and still found only three times here. I know of no other records from Scandinavia.

The species seems fairly well characterized through the regular shape and warm, rich color. The spores are like those of *M. macrosporus* but distinctly smaller and more narrow. *M. tuberiformis* sensu KNAPP (1954) could presumably better be referred to *M. macrosporus*. It seems that CORDA's own concept of the species was unclear. The figure cited above is excellent, while the later figures in Icon. fung. T. IX, Fig. 89 (1854)

show somewhat different spores. The type specimen was studied by ZELLER and DODGE (1937), who found the spores 10–11.5×5.5–7 μ. It is possible that further studies may prove *M. tuberiformis* and *M. intermedius* sensu Z. & D. (non BERK!) to be indistinguishable.

Danish finds: Petersdal by Viborg, J., Sept. 7, 1892, leg. C. GAD (M.H. and PAH7307); – Grib Skov, S., Sept. 17, 1921, leg. SALTO (M.H.) (FERDINANDSEN & WINGE 1922); – ML3220, Fredsskov, Lundeborg, F., June 22, 1950.

Hymenogasteraceae

Peridium thin, smooth, pallid or brownish; gleba with open chambers lined by hymenium; soft, with small or no columella. Basidia 2–4-spored; spores elliptic-citriform, brown, smooth or sculptured; with a distinct gelatinous utriculus. Only the genera *Hymenogaster* and *Chamonixia* are known from Scandinavia.

Hymenogaster VITTADINI

The correct naming of many of the species of *Hymenogaster* is an almost insolvable task. VITTADINI (1831) described eight species, one of which (*H. rufus*) never has been accepted. Three of the remaining species seem uniformly conceived by almost all later authors (viz. *H. luteus*, *H. citrinus*, *H. bulliardi*). These species have not been found in Denmark as yet. TULASNE accepted the four less well defined species, but did not identify them with specimens found by himself. He also took into account six species described by BERKELEY and BROOME, but here he only himself had found material of one of them (*H. tener*), and finally his list includes six species described as new, making a total of 20 species, of which he was familiar with only ten. This should in itself indicate a rather dubious status of many of these taxa. HESSE (1891) managed nevertheless to find 18 of these species in Germany, and described ten additional ones as new, although he did not introduce any new specific criterion of importance. ZELLER & DODGE (1934) tried to reduce this list somewhat, recognizing about 20 European species (plus some described by HESSE, but not seen by them). But SOEHNER (1952a) apparently found this to be much too radical an action, and lists no less than 43 European species, including all the 20 from TULASNE's list, almost all of HESSE's, and several new ones. This large list should be compared with the results obtained by HAWKER (1954), who found no more than seven species herself and adds three more, based on herbarium material, mostly from BERKELEY and BROOME.

Very extensive type studies are necessary before this tangle is cleared up, and severe difficulties will have to be met here, as many of the old specimens are difficult to revive satisfactorily, and also the determination of the proper type is often a complicated and delicate procedure.

The present study is based on examination of about 100 collections seen in fresh condition. They have been compared with authentic specimens from VITTADINI (from Uppsala and Kew Herb.) and also with material kindly submitted by Dr. HAWKER.

The genus is devided in two main groups, to which I at present prefer to ascribe no definite taxonomic rank. The one is characterized by small, verrucose spores, the other by larger spores with smooth or wrinkled-folded utricle. The species of the latter group seem most difficult to delimit.

Key

1.	Spores verrucose, average size $< 18\,\mu$	2
1.	Spores with folded utricle or smooth, aver. size $> 18\,\mu$	4
2.	Peridium pale tan when mature	*H. arenarius* p. 69
2.	Peridium pure white	3
3.	Peridium coarsely fibrillose-silky	*H. tener* p. 66
3.	Peridium appressed fibrillose, spores with isolated warts	*H. niveus* p. 68
4.	Spores smooth, spindleshaped, large	(*H. luteus*)
4.	Spores with folded-wrinkled utricle	5
5.	Spores very large, average $> 25\,\mu$, thickwalled	6
5.	Spores smaller, generally thinwalled	7
6.	Peridium olivaceous tan	*H. olivaceus* p. 74
6.	Peridium bright yellow	(*H. citrinus*)
7.	Mature gleba very dark, chambers small	*H. griseus* p. 72
7.	Mature gleba paler, chambers larger	8
8.	Spores with rounded apex and anastomosing, coarse wrinkles	*H. decorus* p. 73
8.	Spores spindleshaped, wrinkles lower or more wart-like	9
9.	Base of spore acuminate with small claw-like pedicel	*H. vulgaris* p. 70
9.	Base of spores rounded, pedicel thin, not claw-like	*H. muticus* p. 71

Hymenogaster tener BERK. 1844, p. 349.

Fig. 18, p. 67.

Fruit body 1.0–1.8 cm broad, globose or slightly flattened, large specimens somewhat lobed; peridium pure white, drying pale buff, distinctly fibrillose silky, most often with soil incrusted, rather thick, white in section; gleba with small chambers around sterile basal cushion,

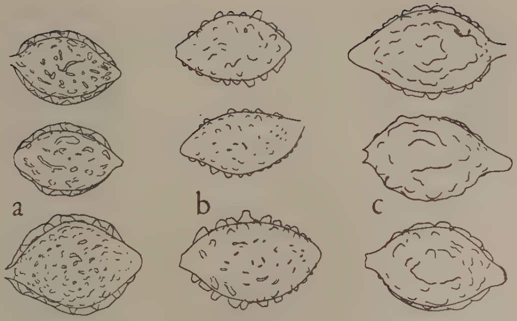

Fig. 18. *Hymenogaster tener*: a Spores (×1100). *Hymenogaster niveus:* b Spores (×1100). *Hymenogaster arenarius*: c Spores (×1100).

larger towards margin, pallid violaceous flesh color when half ripe, then Wood Brown (o6) or often richer colored, Russet (h1), drying Cinnamon Brown (g8).

Smell faint, nutty.

Peridium 200–500 μ thick (fresh), outer thin layer of 1.5–2.5 μ thick hyphae, some protruding like hairs, main layer a large-celled, hyaline pseudoparenchyma; septa 90–180 μ thick (fresh), narrow central layer of 3-5 μ broad hyphae, main body of pseudoparenchymatic subhymenium; basidia 30–38 × 6.5–9 μ, 2-3(4)-spored; spores 10.5–19 × 7.5-12 μ, averages 12.75–17.5 × 8.25–11 μ, with coarse warts or wart-like, short ridges, citriform or more rounded at base, apical part rarely acuminate, pedicel short or lacking, subhyaline sheath generally conspicuous.

Not uncommon, under oak on rich, dark mull, hypogean, solitary or a few specimens together.

The pure white, silky peridium and warm color of mature gleba are the most reliable macroscopic characters of this species, while the large-celled pseudoparenchyma of the peridium and the broadly rounded, irregularly verrucose spores distinguish it microscopically. The anatomical characters are, however, not always easy to ascertain on dried specimens.

There can be little doubt that this is the *H. tener* as described by TULASNE and most of the recent authors, notably SOEHNER, who has dealt extensively with the *Hymenogaster tener* group (SOEHNER, 1923). It is, however, less certain that it really is the plant described by BERKELEY and BROOME. ZELLER & DODGE (1934) found the type material to be a mixture of this species and *H. citrinus*, all distributed as "*H. lilacinus*" TUL. ZELLER & DODGE's description covers quite well, but the Danish specimen cited by these authors (PAH7271) belongs in *H. niveus*. *Hymenogaster argenteus* TUL. is generally considered synonymous.

Danish finds: ML4006, Roden Skov, Lolland, Sept. 4, 1951; – ML4036, Klinteskov, Møen, and ML4037, Liselund, Møen, Sept. 20, 1951; – ML4067, Stenhus, Holbæk, S., Dec. 14, 1951; – ML4170, Regnstruplund by Jyderup, S., Aug. 15, 1952; – ML4204, Rude Skov, S., Aug. 20, 1952; – ML4211, Ryget, Værløse, S., Aug. 22, 1952; – ML4229, Farum Lillevang, S., Aug. 24, 1952; – ML4272, Ebberup Skov, S., Sept. 28, 1952; – ML4432–33, Lellinge, S., Sept. 13, 1953; – ABK44, Rarskov by, Volstrup, J., Sept. 15, 1954; – ABK62, Krabbesholm Skov, J., Sept. 9, 1955.

Hymenogaster niveus VITT. 1831, p. 24

Fig. 18, p. 67.

Fruit body 0.6–2.5 cm broad, almost globose or slightly lobed, smooth, not incrusting soil, obscurely fibrillose; peridium white, faintly tinged buff in age, drying Light Pinkish Cinnamon (h4), thin, white to buff in section; gleba white, soon Pale Grayish Vinaceous to Vinaceous Buff (c7–j1), then pale Wood Brown (pale o6), often preserving a distinct violaceous tinge; septa pallid, sterile base small or absent, rarely more prominent, giving rise to a few columella branches.

Smell nutty.

Peridium 130–225 μ thick (fresh), of loosely woven, hyaline hyphae; septa 70–150 μ thick, of hyaline hyphae, globose elements only in narrow subhymenium or rarely, in old specimens, also a few seen in trama proper; basidia 40–50 $\times$ 7–10 μ, mostly 2-spored; spores 12.5–19 $\times$ 7.5–11.5 μ, averages 14.25–16.75 $\times$ 8.5–10.25 μ, elliptic citriform, both ends generally distinctly pointed, but without specially developed apical part, pedicel indistinct, sculpture of scattered, narrow, high warts and short ridges, pale brown, with inconspicuous remnants of gelatinous sheath.

Common, in deciduous woods, mostly under *Fagus*, on light mull, very often associated with *Tuber maculatum* and *T. rufum*, along drives and paths, hypogeous, rarely partly exposed.

H. niveus is best distinguished from *H. tener* macroscopically on the thinner, more dull, white peridium and more violaceous, dull color of gleba, microscopically on the thinner, fibrillose peridium and the paler spores with isolated warts. Its nomenclatorial status is, however, somewhat unclear. I have studied an authentic specimen from VITTADINI (Kew Herb.) but it is very badly preserved, and helps little in clearing up the original concept. The peridial characters cannot be ascertained from this specimen and the spores revive badly. The original description is not detailed enough to give much help, and may cover *H. tener* and other white species as well. TULASNE knew the species only from specimens

sent from VITTADINI, and his *H. klotzschii* and *H. populetorum* may well be synonymous to *H. niveus*. KNAPP (1941) seems to include the species in his description of *H. arenarius* TUL., while it may correspond to SOEHNER's concept of *H. populetorum*. HAWKER (1954) did not report it from Great Britain, or included it probably in *H. tener*.

Danish finds: PAH7271, Vesterskov, Nykøbing Falster, Sept. 30, 1932, leg. F. H. MØLLER (cp. MØLLER 1933); – PAH7611, St. Hareskov, S., Aug. 21, 1938, leg. N. F. BUCHWALD; – ML3071, Purreskov, Lundeborg, F., Aug. 10, 1949; – ML3224, ibid., June 30, 1950; – ML4029, Vallø Dyrehave, S., Sept. 12, 1951; – ML4066, Frederikslund Skov, S., Dec. 10, 1951; – ML4105, ibid., June 17, 1952; – ML4171–72, Regnstruplund, Jyderup, S., Aug. 15, 1952; – ML4176–77, 4202–03, 4402–04, 4406, Rude Skov, S., Aug.–Sept. 1952–53; – ML4212, Ryget by Værløse, S., Aug, 22, 1952; – ABK13, Jernhatten, Djursland, J., Sept. 1953; – ABK17, Falslev by Assens, J., Sept. 27, 1953; – ABK56, Vindblæs by Hadsund, J., Oct. 10, 1954.

Hymenogaster arenarius TUL. 1844, p. 55.

Fig. 18, p. 67.

Fruit body 0.6–1.5 cm broad, globose or more frequently irregular-lobed; peridium hardly fibrillose, white or dirty white when young, buff to tan or clay color when older and when bruised, drying rather dark brown, brownish in section, rather thin; gleba white at first, then Pale Grayish Vinaceous (c7), soon darkening to Wood Brown-Cinnamon Brown (o6–g8) or as dark as Sepia on drying, distinctly variegated by pallid septa; chambers rather large and long, sterile base and branched columella sometimes present.

Smell like nuts, or sometimes more *Scleroderma*-like.

Peridium 100–250(300) μ thick (fresh), thin outer layer of narrow hyphae, main layer almost pseudoparenchymatic, brownish; septa with narrow central layer of hyphae and prominent subhymenium of inflated, subglobose cells; basidia 2-spored, $40–60 \times 9–10\ \mu$; spores $16.0–20.5 \times 10–14\ \mu$, averages $16.5–18.25 \times 11–12.5\ \mu$, rather dark, citriform with distinct apical protraction in most spores, pedicel rather small, epispore sculptured from coarse warts and anastomosing, short ridges covered by gelatinous sheath.

Rather common, in woods of *Fagus*, often along paths, hypogeous in sandy light mull.

H. arenarius is distinguished from *H. tener* and *H. niveus* on the dull tan color of the peridium, and the dark, variegated gleba. The spores are very much like those of *H. tener*, but almost always with a protracted

apiculus. The type specimen (Paris Herb.) has been examined and agrees well with the material described above.

Danish finds: ML3315, Dyrehaven, S., Aug. 5, 1950; – ML4062, Fussingø by Randers, J., Oct. 21, 1951, leg. KLINGE; – ML4155, Frederikslund Skov, S., Aug. 13, 1952; – ML4166–67, 4178, 4194–95, 4230, 4414, Rude Skov, S., Aug.–Sept. 1952–53; – ML4419, 4429, 4431, Krogenberg Hegn, S., Sept. 6–9, 1953; – ABK27, Skablunde Skov by Horsens, J., June 26, 1954; – ABK57–58, Ajstrup Skov by Hadsund, J., Oct. 10, 1954.

Hymenogaster vulgaris TUL. in BERK. & BR. 1846, p. 74.
Fig. 19, p. 71.

Fruit body 0.4–1.0 cm broad, globose or somewhat flattened, rather soft; peridium dull whitish, in older specimens with a pallid brown sheen, (Pinkish Buff, g6 – Light Pinkish Cinnamon, h4), fibrillose, but not conspicuously so, often cracked in places, rather thin; gleba of moderately large chambers, white at first, then Light Brownish Olive (c3), no distinct violet tinges noted; septa brownish olive, drying almost white, giving gleba a mottled appearance, columella absent or present only as a flat sterile cushion at base.

Smell nutty or faint.

Peridium 100–200 μ thick, of inflated, short-celled hyphae, 4–10 μ broad, subparallel or interwoven, pale brown; septa about 100–150 μ thick, trama 50 μ, of 2–4 μ broad hyphae; basidia mostly 2-spored, 30×7–$8\ \mu$, almost cylindrical, some of them longer, up to 65 μ, sterigmata short; paraphyses 7 μ broad; spores 17–24(29) $\times$ 7.5–12.0 μ, averages 19.75–21 $\times$ 10.25–11 μ, also some dwarfish spores seen in almost all mounts (14 μ long) and a few twin spores; spore wall rather thin, utriculus wrinckled, with irregular longitudinal structure making some spores appear as warty; epispore finely warty, pedicel thinwalled or slightly thickened to small basal claw, apex almost naked and pale.

Probably not uncommon, in light mull in woods of *Fagus*.

The species shares spore characters with *H. lycoperdineus* VITT., but the authentic specimen, I have studied (Herb. Uppsala), and also the original illustration indicate a much larger plant, and the interpretations of the species are altogether rather variable, so TULASNE's name is preferred as the description fits my plant well. Specimens from HAWKERS collection have proved identical, or with spores slightly more warty than in most of my material (also more warty than indicated in HAWKER's illustration (1954, Fig. 28 k)).

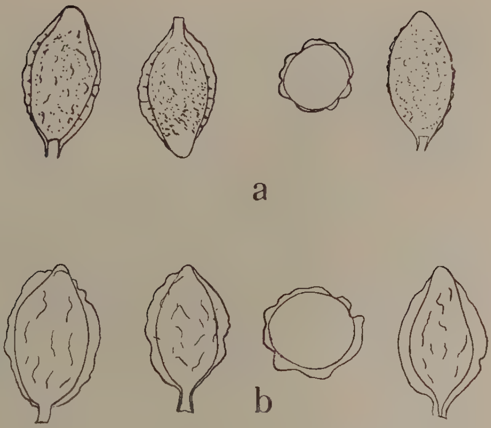

Fig. 19. *Hymenogaster vulgaris*: a Spores (×1100). *Hymenogaster muticus*: b Spores (×1100).

These specimens may represent *H. rehsteineri* Buch. (1901), by Zeller & Dodge (1934) supposed to be identical with *H. verrucosus* Buch. Soehner (1943) found *H. rehsteineri* to be one of the most common species of *Hymenogaster*. However this may be, I still find my material well covered by Tulasne's description, and not specifically distinct from *H. vulgaris* sensu Hawker.

Danish finds: ML3100, Purreskov by Lundeborg, F., Aug. 10, 1949; – ML4065, Frederikslund Skov, S., Dec. 12, 1951; – ML4156, ibid., Aug. 13, 1952; – ML4169, 4179–81, 4184, 4287, 4401, 4405, 4407, Rude Skov, S., Aug.–Sept. 1952–53.

Hymenogaster muticus Berk. & Br. 1848, p. 267.

Fig. 19, p. 71.

Fruit body 0.6–1.3 cm broad, almost globose to somewhat lobed, rather firm; peridium obscurely fibrillose, dull whitish, turning Brownish Olive (f6) in age and when bruised, at last almost black, in section brownish; young gleba with violaceous tints, then Wood Brown (o6) to Brownish Olive (f6), Bistre when fully ripe (c3); chambers small, sterile base sometimes quite prominent.

Peridium 125–270 μ thick (fresh), 75–100 μ (revived), outer layer of narrow subparallel, almost hyaline hyphae, main layer of broad hyphae with short cells, in places almost pseudoparenchymatic, brownish, cells 6–12 μ broad, becoming more narrow and longer towards gleba; septa 70–100 μ broad, trama 25 μ broad, of narrow hyphae; basidia 23–50 × 9 μ, some of them protruding, 2–3(4)-spored; spores 16–24 × 8.5–13 μ,

averages 18.25–20.5 × 9.75–11.5 μ, rather dark, pedicel pale, thinwalled, rarely clawlike, distinctly set off from slightly rounded base; apex not prominent, utriculus distinct, somewhat irregular in outline, giving some spores a warty appearance.

Probably not uncommon, in deciduous wood on light soil.

The material is referred to *H. muticus* with some doubt. The species seems close to *H. vulgaris*, differing mainly in the darker colors of the ripe peridium and probably also in the violaceous tinted gleba. There is a slight but constant difference in spore shape, the base of the spores in *H. muticus* is more rounded, the pedicel well set off from base, and thinwalled, nearly never forming claw.

Danish finds: ML4168, 4186, 4207, 4337–40, 4434, Rude Skov, S., Aug.–Sept. 1952–53; – ML4228, Farum Lillevang, S., Aug. 24, 1952.

Hymenogaster griseus VITT. 1831, p. 23.

Fig. 20, p. 73.

Fruit body 0.7–2.0 cm broad, slightly to prominently folded-irregular, firm; peridium whitish at first but soon dull Tawny Olive (h2), brown in section; gleba with small chambers, almost stuffed with spores, white when young, soon pallid violaceous and rapidly darkening to dark Bistre (c2–3); the septa paler, more olivaceous, giving gleba a very distinct mottled appearance.

Smell sweetish-nutty, rather strong.

Peridium 140–280 μ thick (fresh), 80–150 μ (revived), outer thin layer of narrow hyphae, main layer of brown short-celled, broad hyphae, in places pseudoparenchymatic and elements up to 20 μ broad, in other parts more narrow, 4–6 μ broad; septa 110–150 μ thick (fresh) of narrow, brown hyphae, paraphyses 30 × 13 μ; basidia 30 μ long, with long sterigmata, spores with prominent pedicel, sometimes clawshaped, apical part not much pointed, utricle distinct, irregularly wrinkled, 18–28.5 × 9.5–15 μ, averages 22–23.25 × 10.5–13.5 μ.

Not common, in deciduous woods.

The species is best recognized on the very dark and firm, small-chambered gleba. VITTADINI's description covers very well, but later concepts seem to vary. An authentic specimen (Herb. Uppsala) agrees, however, with the present material.

Danish finds: ML4213–16, Ryget by Værløse, S., Aug. 22, 1952; – ML4280, Frederikslund Skov, S., Oct. 1, 1952; – ML4435, Rude Skov, S., Sept. 13, 1953, leg. LISE HANSEN.

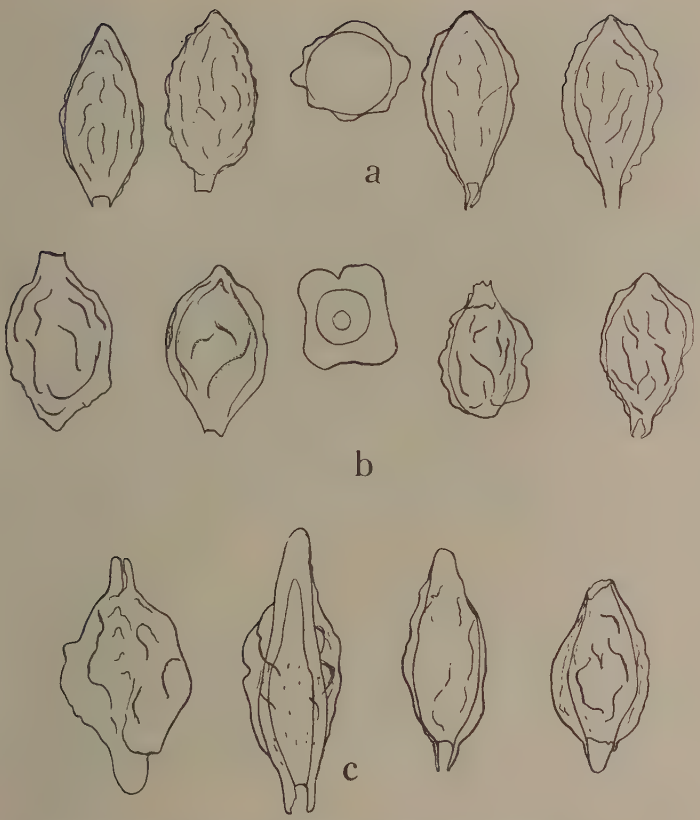

Fig. 20. *Hymenogaster griseus:* a Spores (×1100). *Hymenogaster decorus*: b Spores (×1100). *Hymenogaster olivaceus*: c Spores (×1100).

Hymenogaster decorus TUL. 1843, p. 374.

Fig. 20, p. 73.

Fruit body 0.7–1.2 cm broad, almost globose or somewhat flattened, more or less irregularly lobed; peridium dull pale Clay Color (h3) or pale cinnamon, inconspicuously fibrillose, slightly hairy in places, brown in section; columella absent or present as small sterile base, gleba Wood Brown (o6), Cinnamon Brown or Bistre (g8–c3) when ripe, septa paler.

Smell faint, spermatic.

Peridium 100–270 μ thick (fresh) 75–150 μ (revived), with an inconspicuous outer fibrillose layer, some hyphal ends protruding like hairs, 1.5 μ

broad; main layer pseudoparenchymatic, cells inflated, 6–16 μ broad, brown, more or less distinct fibrillose layer near gleba; septa 75–170 μ thick, main trama layer of brownish hyphae; basidia 9–10 μ broad, 2-spored, with very coarse sometimes brown sterigmata; young spores formed as irregular, elliptic swellings; spores 17.5–25 × 10–14 μ, averages 20–23 × 11.75–13.5 μ, few or more frequently no distinct "nebensporen"; utriculus prominent, strongly wrinckled, the wrinckles anastomosing, forming a net-like sculpture, seen from apex as 4–6 regular longitudinal ribs; apex rounded, more rarely acuminate, almost always covered by utriculus; pedicel clawlike or more irregular, thickwalled and broad.

Met with in deciduous wood (*Quercus*, *Tilia*, *Fagus*), often on rather good soil.

The dark brown spores with more or less distinctly rounded apex and netlike sculpture of utriculus distinguish the species well from those previously listed. However, the species seems to be very close to *H. olivaceus*, and it may be regarded as a small-spored form. *H. olivaceus* sensu HESSE is probably synonymous, and also *H. hessei* SOEHNER seems closely allied.

Danish finds: ML4068, Stenhus Skov, Holbæk, S., Dec. 12, 1951; – ML4183, Rude Skov, S., Aug. 19, 1952; – ML4236, Vintersbølle Skov, Vordingborg, S., Aug. 27, 1952; – ML4242, Snedkerskov, Randers, J., Sept. 4, 1952; – ML4243, Fussingø, J., Sept. 4, 1952; – ABK5, ibid., Aug. 10, 1953, – ML4418, 4430, Krogenberg Hegn, S., Sept. 6–9, 1952; – ABK34, Klausholm Park by Randers, J., Aug. 22, 1954; – ABK50, Hvidding Krat by Hammershøj, J., Sept. 18, 1954; – ABK55, Vindblæs by Hadsund, J., Oct. 10, 1954.

Hymenogaster olivaceus VITT. 1831, p. 24.

Syn.: *H. calosporus* TUL. 1851.

Fig. 20, p. 73.

Fruit body 0.9–2.5 cm broad, somewhat lobed, rather firm; peridium dull Pinkish Buff (g6), slightly fibrillose; gleba Grayish Vinaceous (c7), then Cinnamon Brown to Bistre (g8–c3); septa more olivaceous pale, chambers empty, rather large, about 0.3–1 × 0.2–0.4 mm.

Smell slight, nutty.

Peridium about 225 μ thick (fresh), 110 μ when revived; outer thin layer of 3 μ broad hyphae, main layer a brown pseudoparenchyma, the cells 6–16 μ broad, inner layer fibrillose; septa 100–160 μ, the trama 50–60 μ thick, central layer of brownish hyphae, subhymenium of more inflated cells; basidia 2-spored, some of them with stout, brownish

sterigmata; spores spindelshaped, with prominent subhyaline, protracted apex and clawlike pedicel, thickwalled, deep brown, utriculus irregularly wrinckled, 24.5–36 × 11.5–16 μ, averages 25.5–31 × 12–15 μ, very long and narrow spores generally present (not incl. in measures).

Not common, found in deciduous wood (*Quercus*, *Tilia*) on calcareous soil, often partly exposed.

The species seems well characterized by the large, prominently apiculate, thickwalled spores, although the spores vary considerably inside this pattern. There is, however, some doubt as to the significance of these spore characters. ZELLER and DODGE (1934) consider *H. decorus* TUL. and *H. calosporus* TUL. as synonyms but this is disputed by SOEHNER (1943). *H. olivaceus* sensu SOEHNER may be a distinct taxon, intermediary between *H. decorus* and *H. olivaceus* as here concieved. I have seen an authentic specimen of VITTADINI's *H. olivaceus* (Uppsala Herb.), which certainly is identical with the material described here, and also identical with *H. calosporus* TUL. Further studies may well show it most correct to follow the suggestion of ZELLER and DODGE, and unite all the taxa sub. nom. *H. olivaceus*.

Danish finds: M.H. & PAH7432, Lerchenborg, S., Dec. 12, 1884, leg. C. PEDERSEN (ROSTRUP 1885, as *H. vulgaris*); – ML3249, Krogerup, S., June 28, 1950; – ML4035, Klinteskov, Møen, Sept. 20, 1951; – ML4241, Snedkerskov by Randers, J., Sept. 4, 1952; – ABK33, Ø. Velling Skov by Randers, J., Aug. 22, 1954.

A few specimens of *Hymenogaster* remains undetermined, as they are unripe or poorly developed. One of these has previously been recorded as *H. citrinus* (M. LANGE 1953) but seems to belong in the *H. vulgaris* group.

Chamonixia ROLLAND

Young fruit bodies with small but distinct stipe, inserted in small groove in peridium; peridium white, turning bright blue when touched; gleba chambered as in *Hymenogaster*. Spores brown, with longitudinal ribs. *Chamonixia caespitosa* **Rolland** is recorded from Norway (LANGE & HAWKER, 1952).

Gautieriaceae

Peridium almost absent in mature specimens, leaving large-chambered gyrose, cartilaginous gleba almost naked. Basidia in hymenium, 2-spored with sterigmata; spores brown, with longitudinal ribs. Only genus **Gautieria** VITTADINI. Two or three species known from Scandinavia, but not recorded from Denmark (cp. FRIES, 1921).

Hysterangiaceae

Peridium white, smooth, generally with one or several rhizomorphs at base; gleba green or bluish green, gyrose-cartilaginous, over branched columella; chambers stuffed with spores. Spores almost sessile, cylindric-elliptic, subhyaline, rather large. Only the genus *Hysterangium* VITTADINI is known from North Europe.

Hysterangium VITTADINI

The present author has made no collections of this genus in Denmark, and the five herbarium specimens available are, with one exception, very poor. *Hysterangium* has recently been monographed by SOEHNER (1952), who lists a large number of European species. It is highly possible that some more of these occur in the few, rich calcareous Danish tracts.

Key

1. Spores large, about 25 μ long .... *H. stoloniferum* p. 76
1. Spores much shorter .... *H. coriaceum* p. 76

Hysterangium stoloniferum TUL. 1843, p. 376.

Peridium 1–2 cm broad, almost globose, white, with a coarse rhizomorph springing from the base; peridium easily separable; gleba greenish olive when young, light brownish olive when mature; columella distinct, much branched.

Peridium about 200 μ broad (revived), outer layer 100 μ broad, made up of pseudoparenchymatic tissue, rich brown in KOH, narrow central layer dark brown over a 75 μ broad layer of pale brownish tissue with indistinct hyphal structure; septa gelatinized, basidia mostly 3-spored, spores 24–26 × 6.5–8.5 μ, mostly with a distinct remnant of sterigma.

Only found once in Denmark, in beechwood on calcareous soil.

Danish find: Klinteskov, Møen, May 24, 1893 (cp. ROSTRUP 1895) (M.H. and PAH7405).

Hysterangium coriaceum HESSE 1891, p. 101.

For detailed description see SOEHNER (1952).

Fruit body small, about 1 cm diam. almost globose with a distinct mycelial tuft at base; peridium whitish, dull brown when dry, easily pealing off; gleba dark olive green.

Peridium with a main layer of pseudoparenchyma, the cells 15–35 μ

broad, dull brown in KOH, inner layer of almost hyaline hyphae with clamp connections; hymenium with a few scattered cystidia, acuminate, inflated below, about 30–35 × 8–9 μ; basidia mostly with 4–6 spores; spores 12–13.5 × 4–4.5 μ.

The small-spored species of *Hysterangium* were previously referred largely to *H. clathroides* VITT. FISCHER (1938) demonstrated, however, that the type material had no pseudoparenchyma in the peridium. The present specimen seems to agree best, though not entirely, with *H. coriaceum* as conceived by SOEHNER. The original spore measures given by HESSE for the species found only once by him are smaller. SOEHNER found the species to be a common one, and his spore measures are but a fraction smaller than mine.

Danish find: ML4462, Ørnereden by Århus, J., Sept. 25, 1953, leg. K. BÜLOW.

There are two other Danish collections of *Hysterangium*, both very badly preserved. A specimen from Stallerup (leg. POUL LARSEN, July 26, 1924) could possibly belong in *H. coriaceum*, but the gleba is paler, and the structure of the peridium seems to differ. A specimen from Hulsø, Rude Skov, May 1890, (leg. JON. LANGE) is different from all described species of the genus through its very broad spores (15–16.5 × 8.5–9.5 μ). The material, one fruitbody only, is insufficient for detailed description, and certainly not enough to form the basis of a new taxon.

Fungi imperfecti

Very few members of this large group of fungi reach such a size that they are regarded as members of the "fungi hypogei". The genus *Leucophleps* HARKN. is considered an imperfect stage of *Leucogaster*, but neither the former nor the latter have been found in Denmark. Several members of the form genus *Sclerotium* are large enough to be a source of disappointment when collecting hypogeous fungi, but they are usually excluded from the treatments which by tradition accept only one of these species, *Cenococcum graniforme* FR.

Cenococcum graniforme FR.

Fruit body small, size of a small shot, globose or nearly so, black, hard and brittle, hollow. No spores or conidia formed. The species is exceedingly common in Denmark. It has been dealt with in great detail by FERDINANDSEN and WINGE (1925)

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